

expEYES

A portable Science Laboratory

<http://expeyes.in>

FOSS.IN 2012

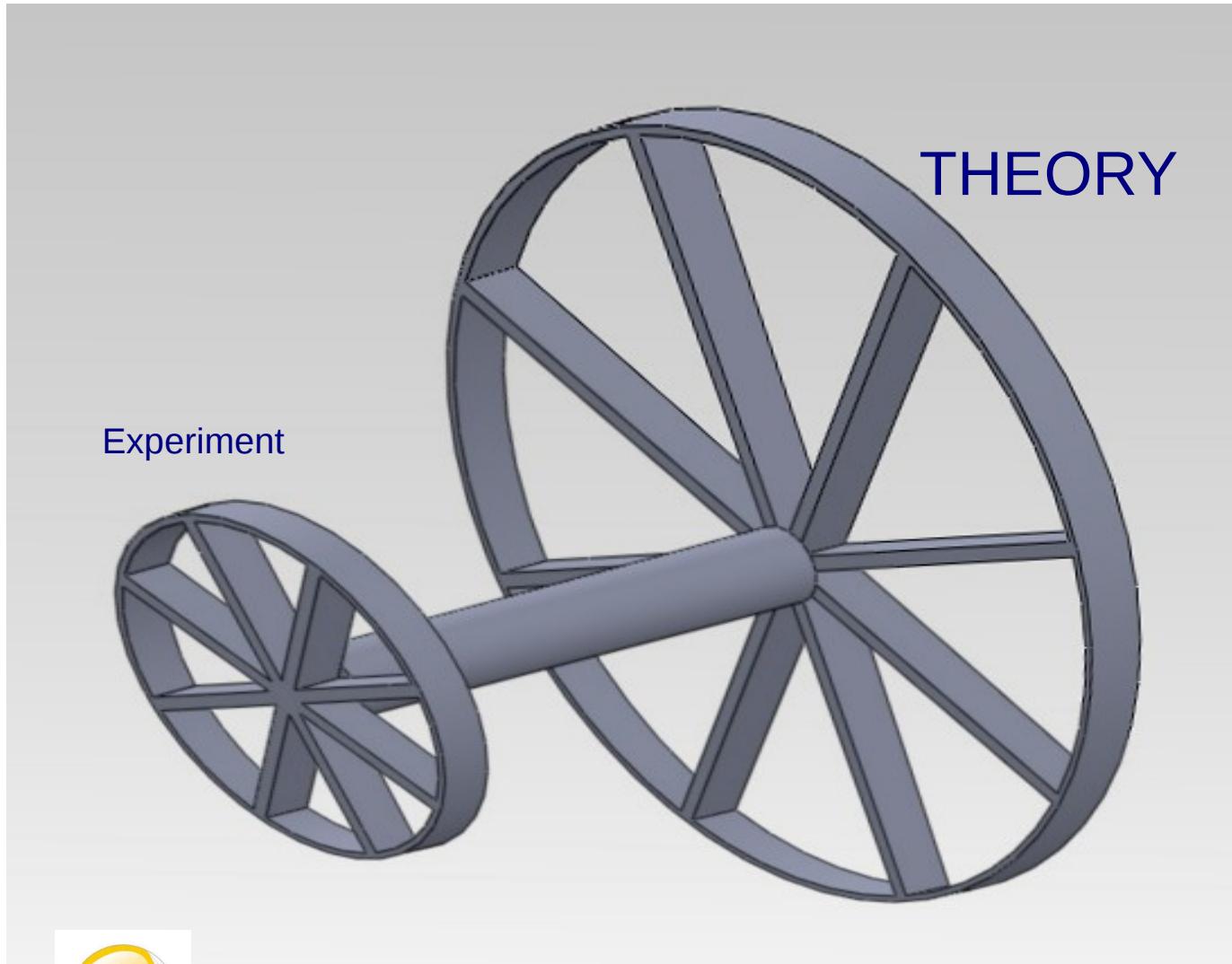
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Inter-University Accelerator Centre
New Delhi 110067

ajith@iuac.res.in www.iuac.res.in

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



Our Science/Engineering Education



.. 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 ?

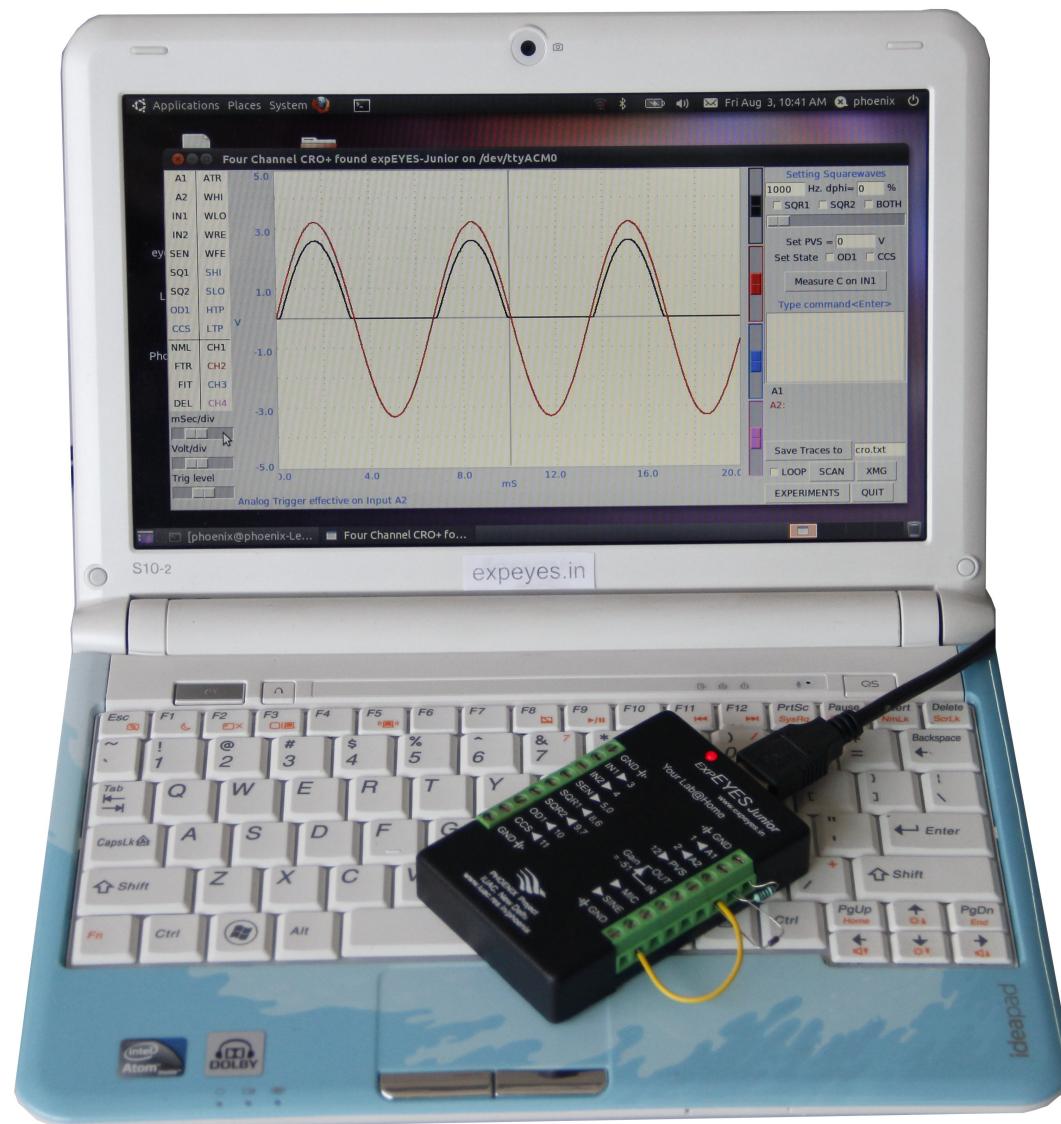
A low cost device that can generate/measure voltages as a function of time and generate graphs.

A tool for learning by exploring.

Supports Science & Engineering experiments from High School to Post Graduate level.

A test equipment for electronics hobbyists.

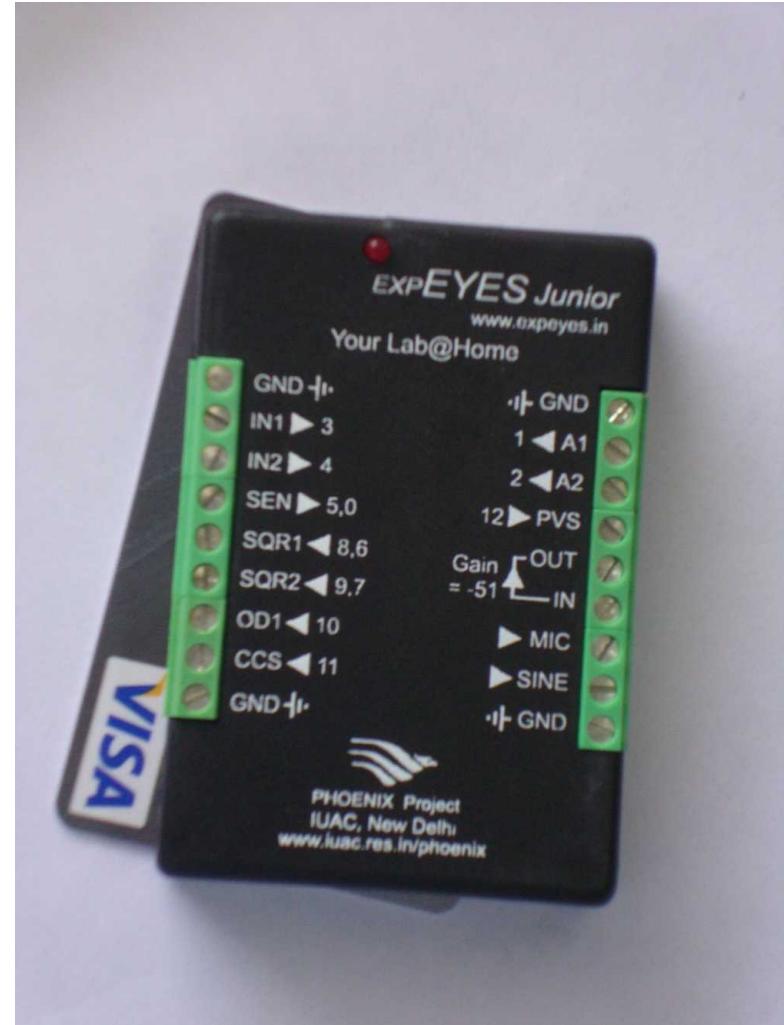
All with Open Software & Hardware



ExpEYES on a netbook, studying a PN junction Diode

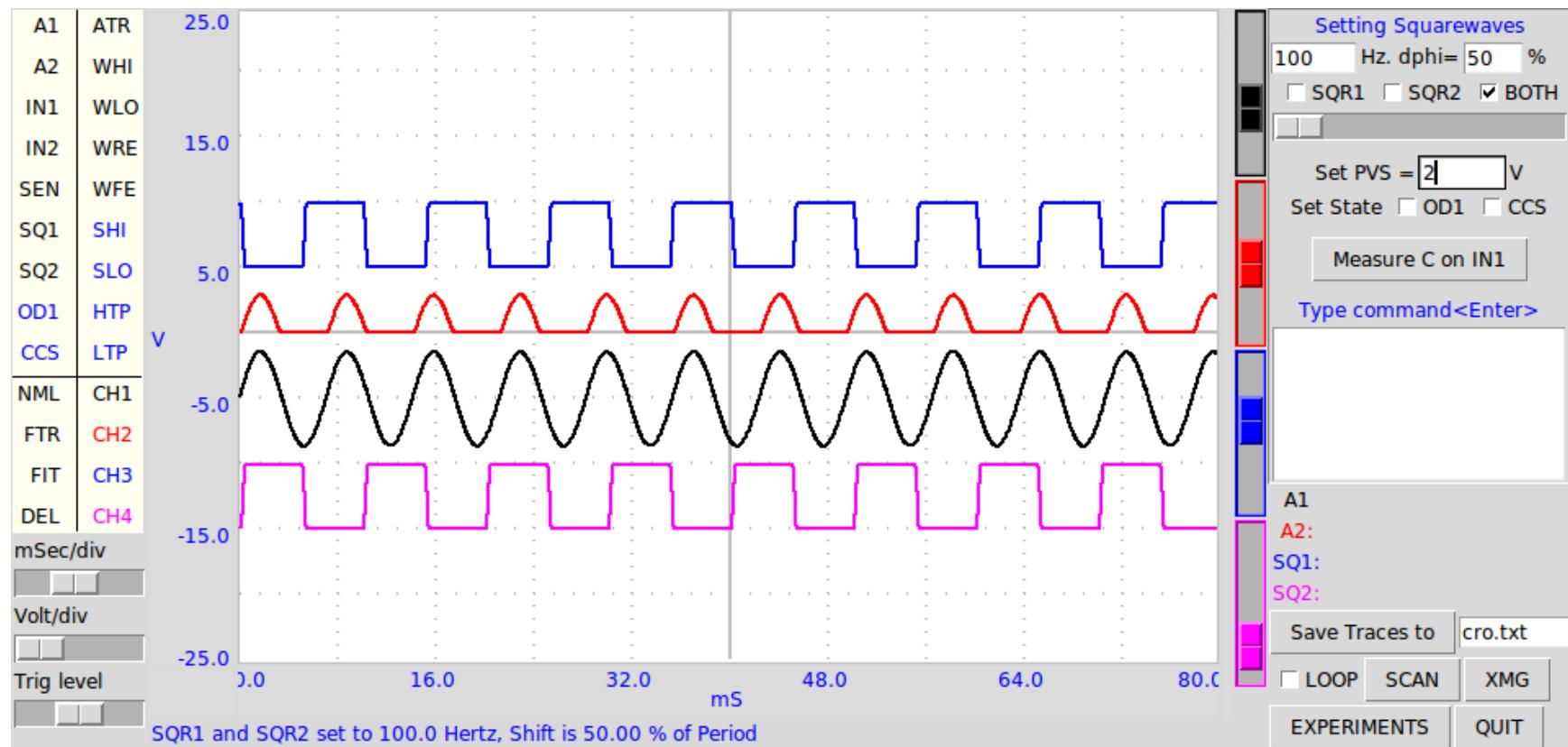
Features:

- 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 cm³, 60 gm.
- Open Hardware

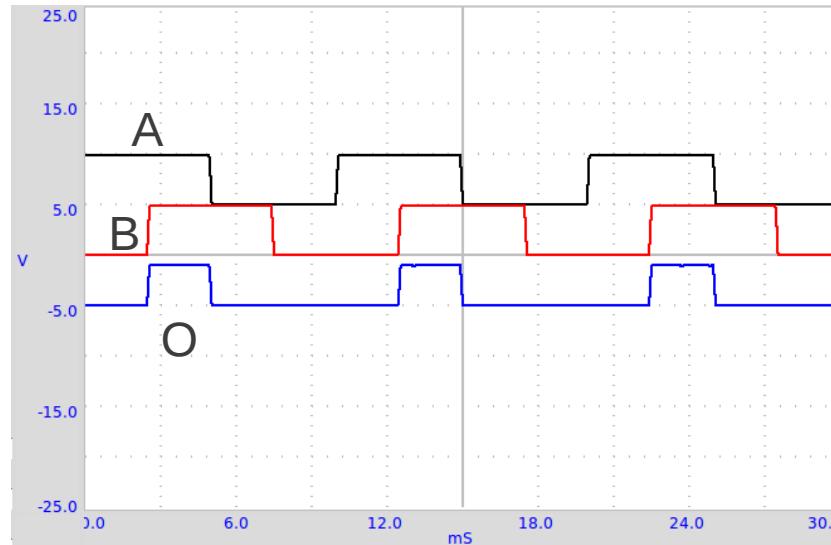
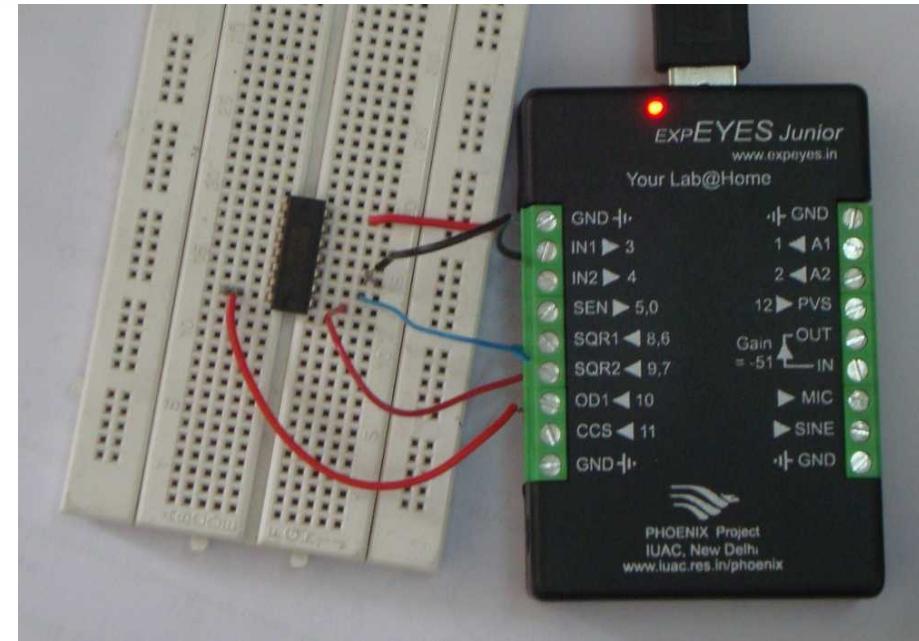


GUI programs available for around 50 experiments

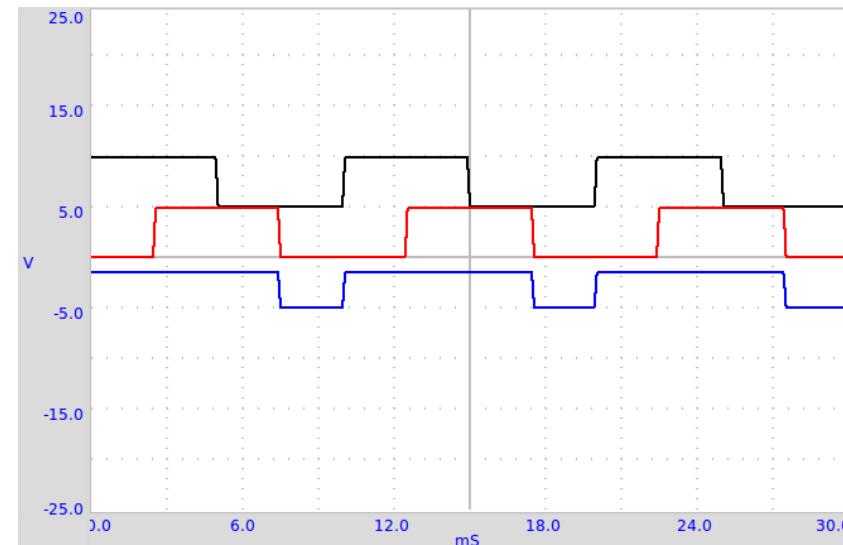
Example 1: Four channel CRO (250 ksps)



Study of Logic Gates

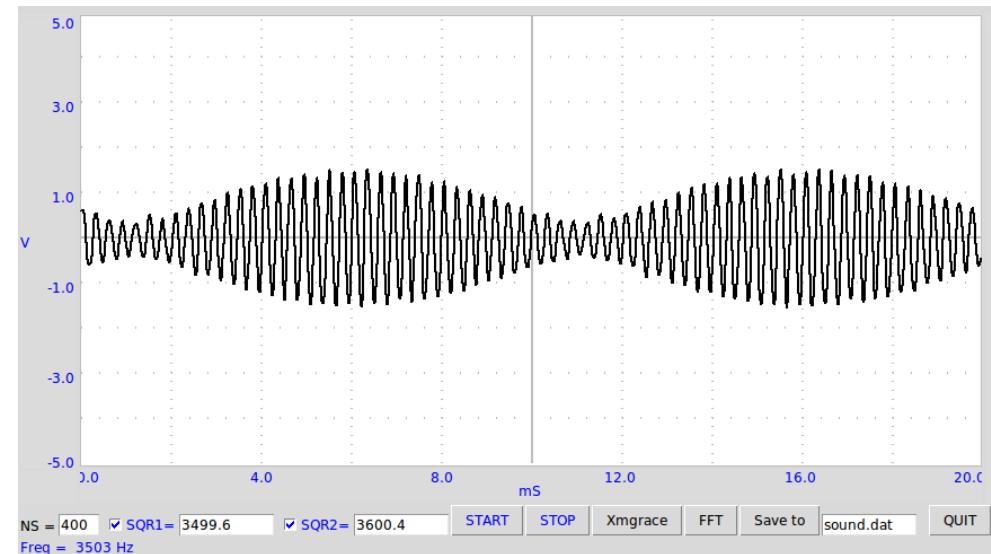
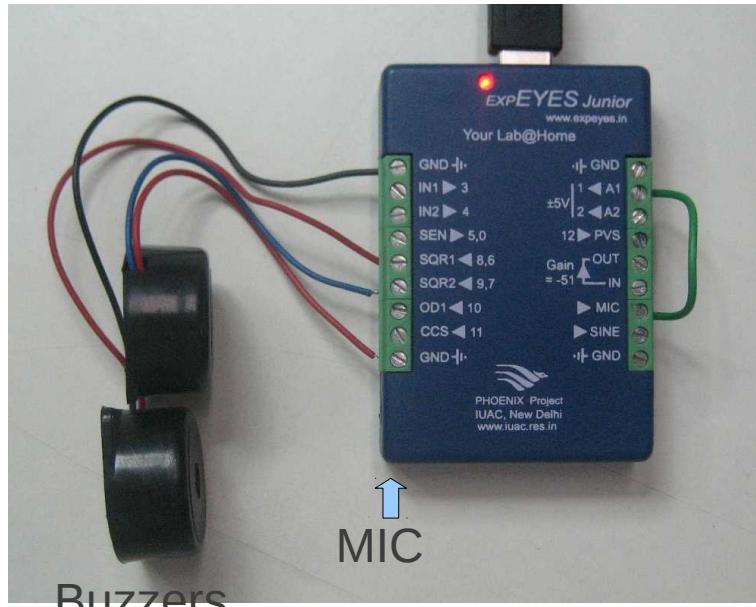


AND Gate

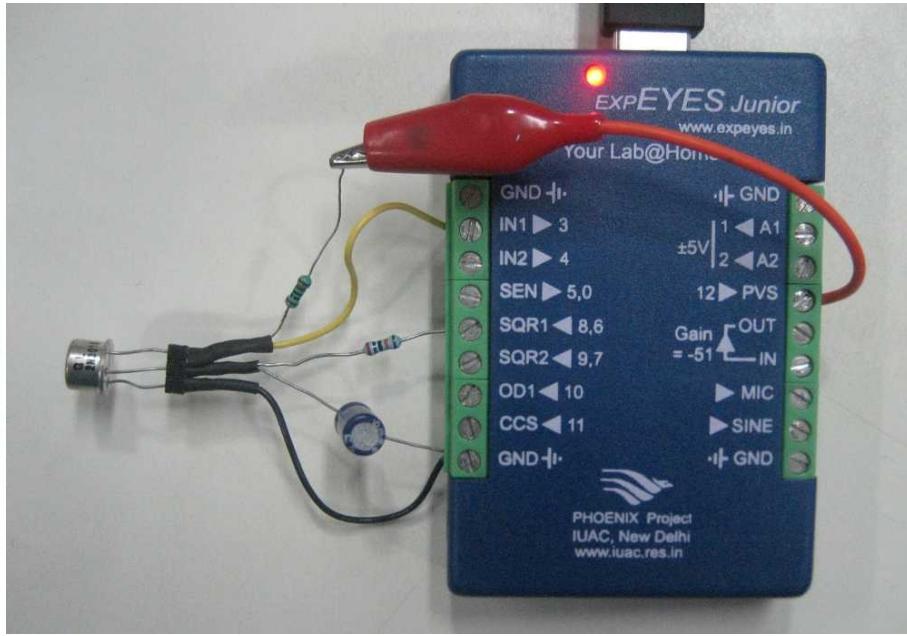


OR Gate

Interference of Sound

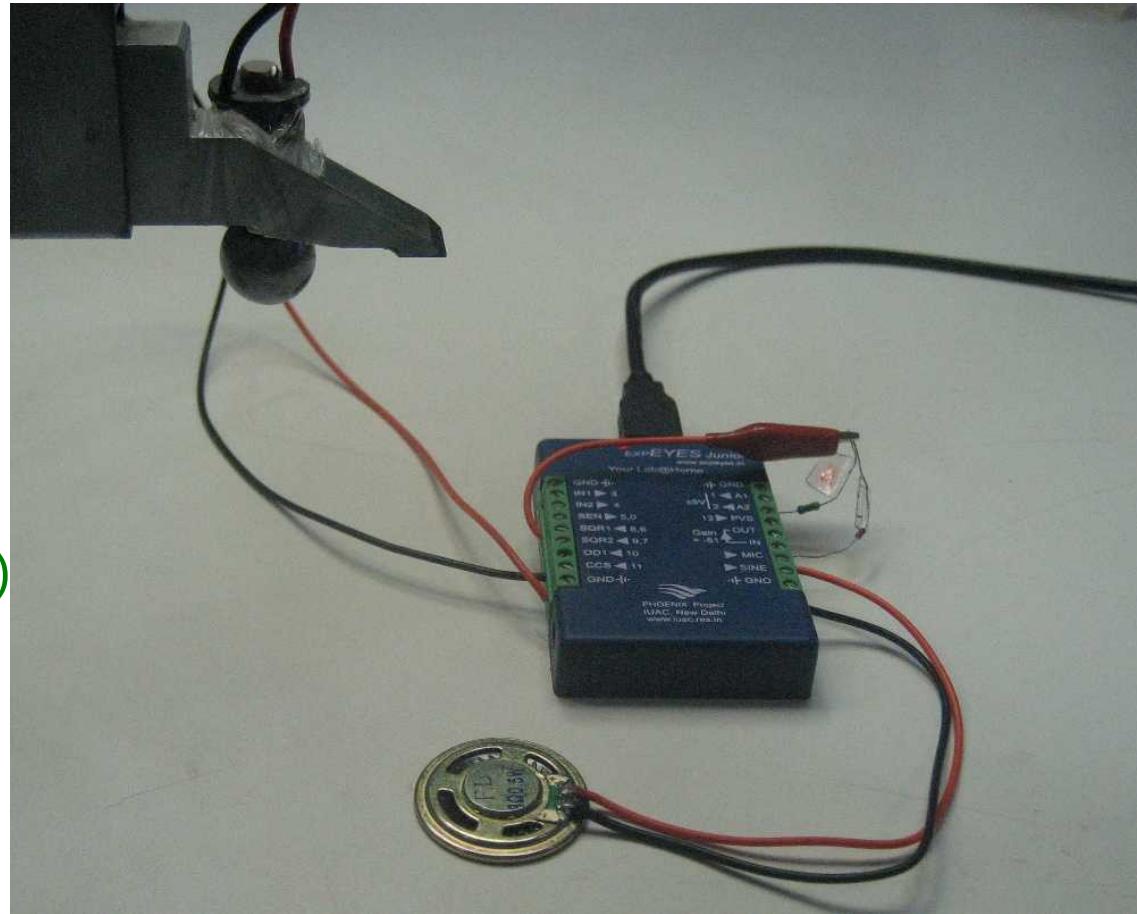


Transistor Characteristics



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.

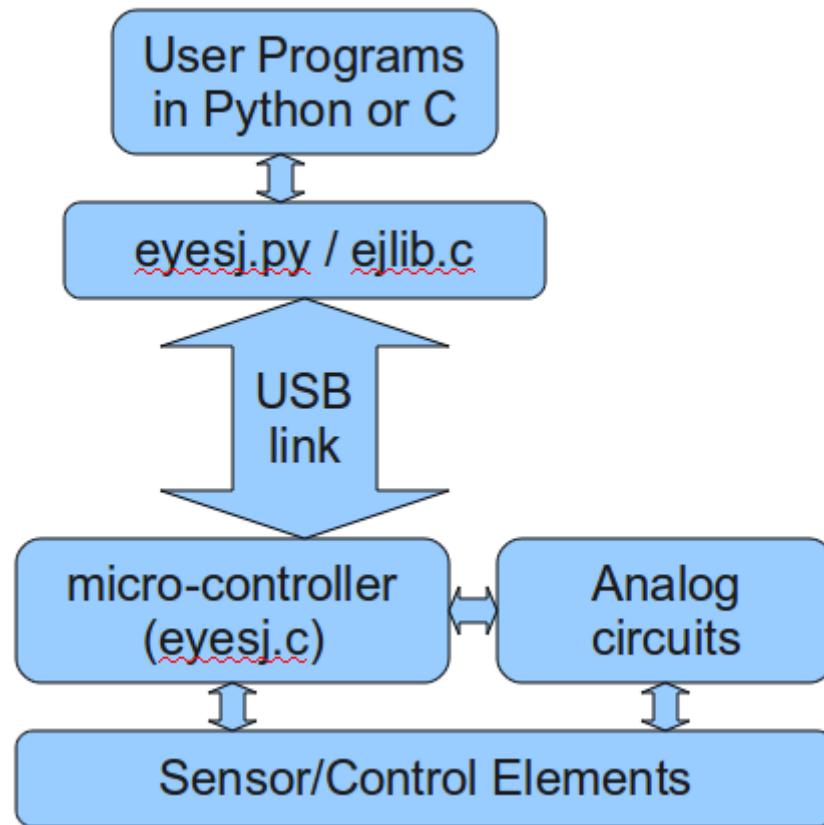
And many more ...

<http://expeyes.in>

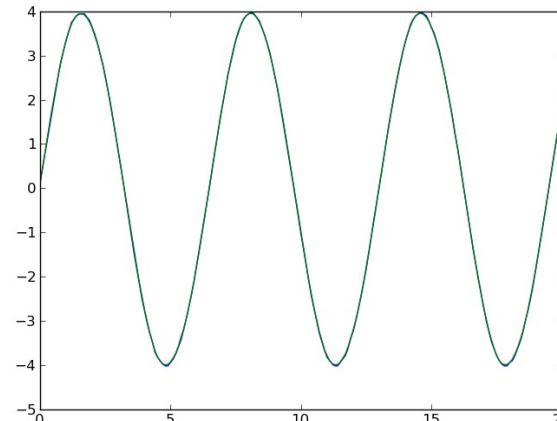


Design of expEYES Junior

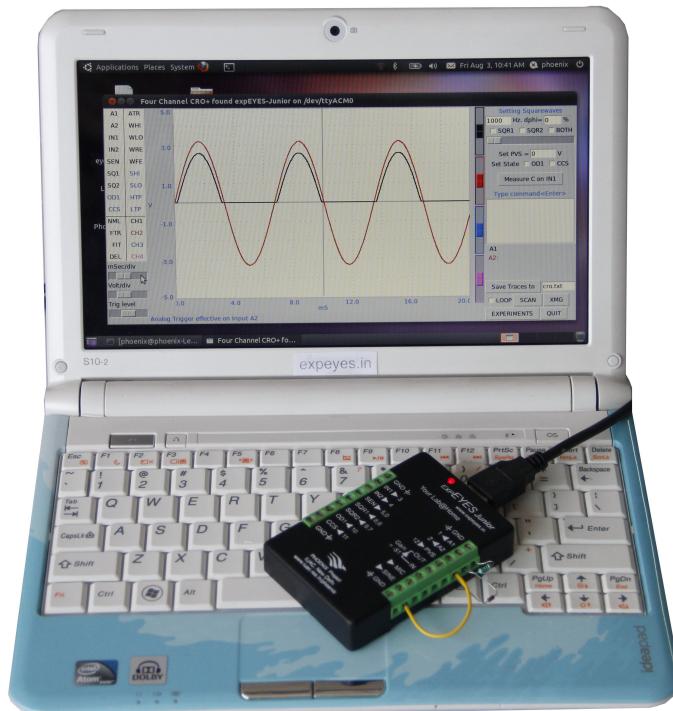
Real-time measurement features of Micro-controller
+
Computational and Graphics capability of Python.



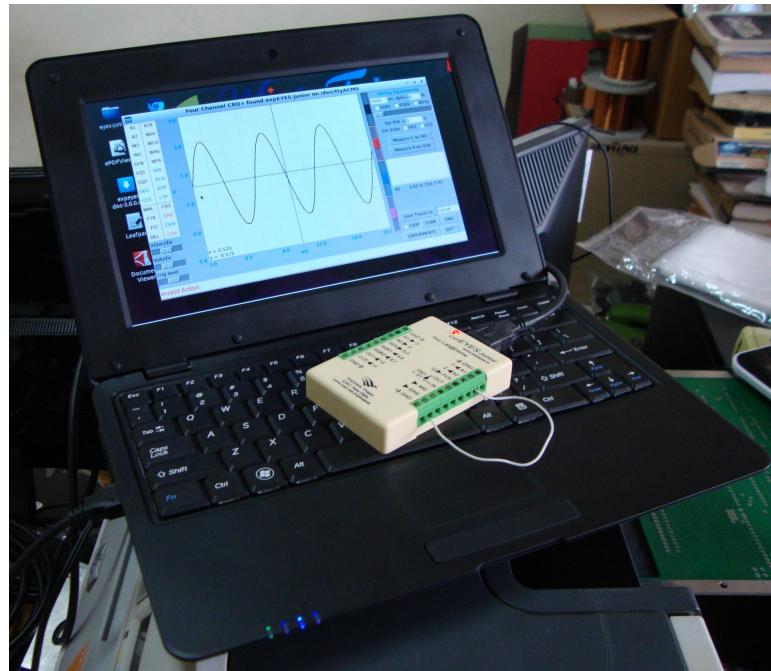
```
import expyes.eyesj
p = expyes.eyesj.open()
from pylab import *
t,v = p.capture(1, 200, 100)
plot(t,v)
show()
```



Reducing total cost: cheaper computers.

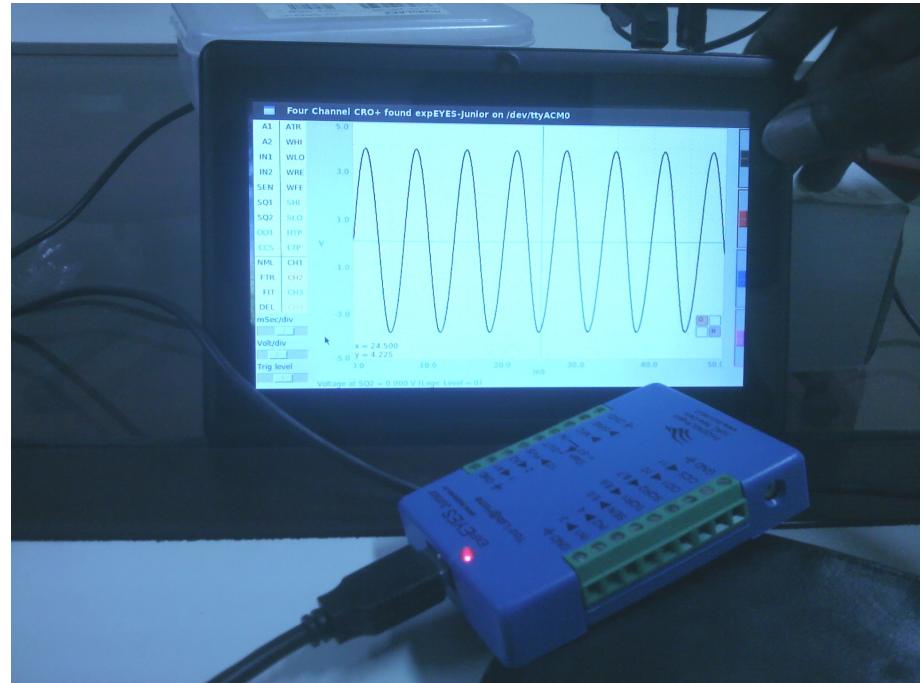


Netbooks with Atom processor.
Costs around 13000/-



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

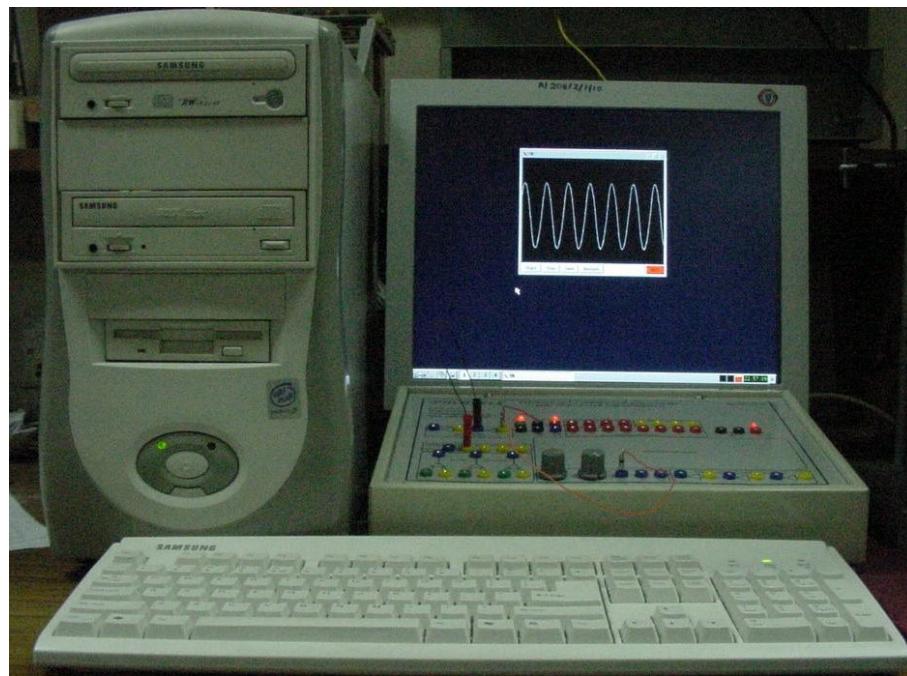
Students : An affordable tool for doing experiments, anytime anywhere. Freedom from the lab timings.

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

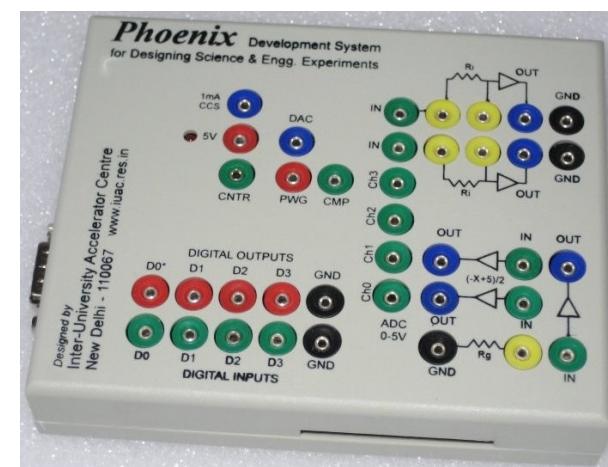
Engineers : An open system that combines basic physics, electronics, micro-controller programming, computer interfacing, GUI programming and scientific computation.

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.



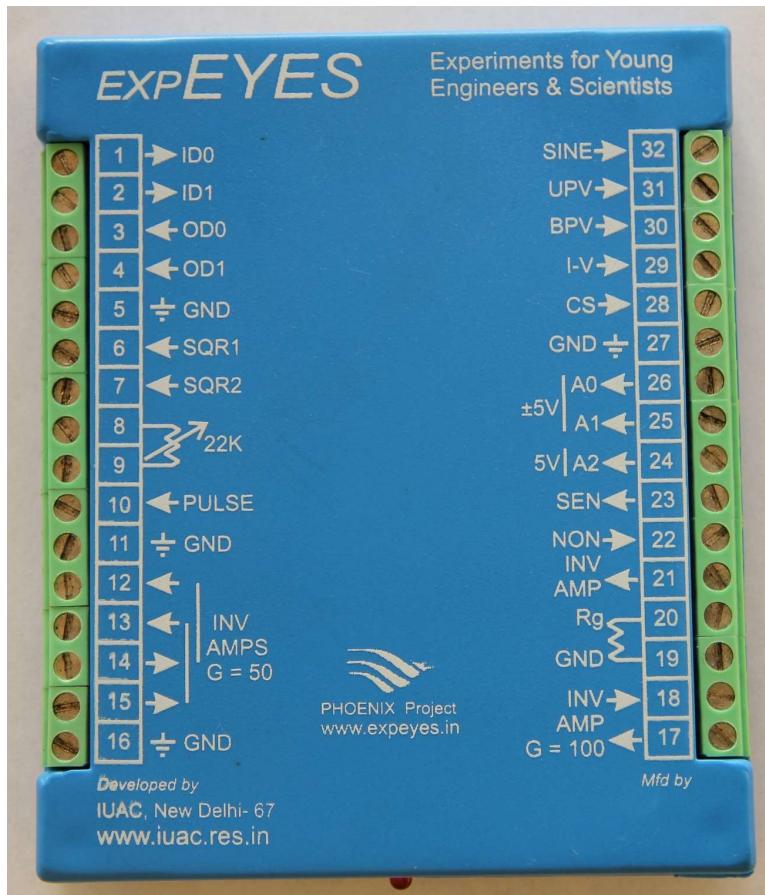
2005 : Parallel port device,
Linux / DOS
C code



2006: micro-controller version
RS232 / USB options.
Python code

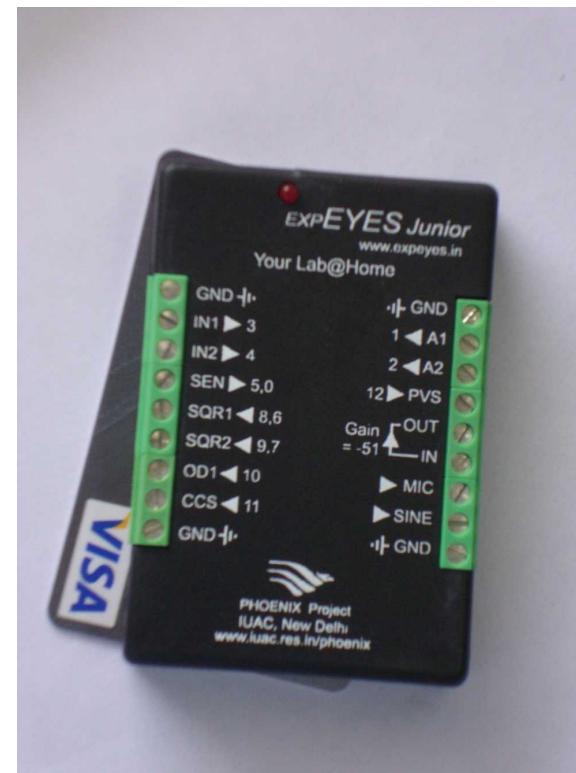
2011: expEYES

- 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)

python phoenix - Google Search - Mozilla Firefox

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[Experimental Physics with Phoenix and Python LG #111](#)

Being a **Python** fan, one of the first things I did with the **Phoenix** box was to try and write a simple **Python** library for talking with the hardware. ...

[linuxgazette.net > February 2005 \(#111\) - Cached - Similar](#)

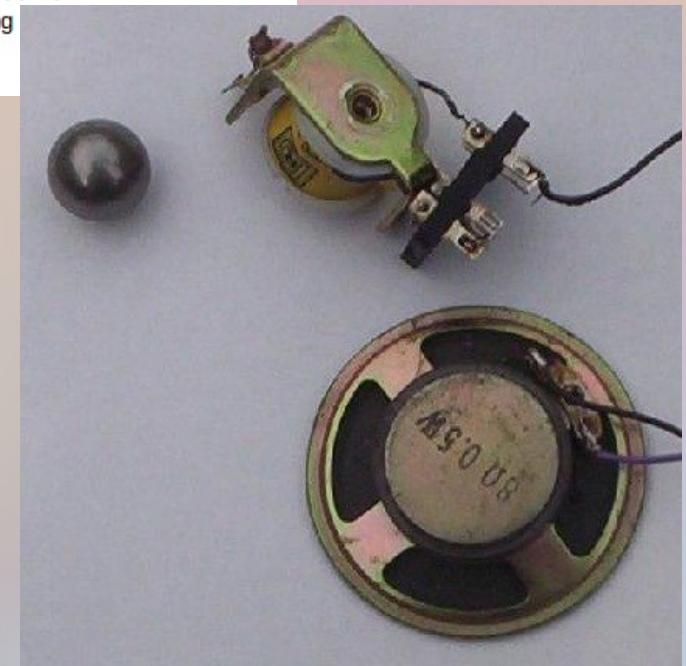
[Phoenix : Science Experiments. USB Serial computer Interface. Data ...](#)

Phoenix depends heavily on **Python** language. The data acquisition, analysis and writing simulation programs to teach science and computation. ...

[www.iuac.res.in/~elab/phoenix/ - Cached - Similar](#)



<http://pramode.net>



Value of 'g' from Time of Flight, (using electromagnet, ball & speaker)

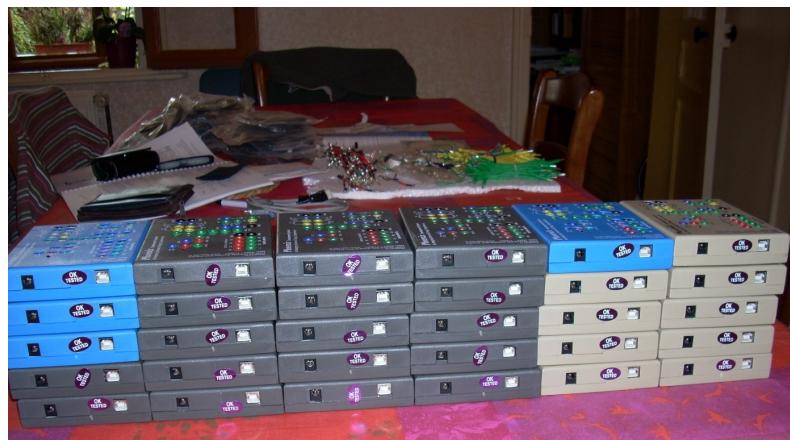
```
from phoenix import *
p = Phoenix()
p.write_motors(0xf) # Energize the coil
t = p.get_drop_time() # Drop the ball and time it!
print t
```

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



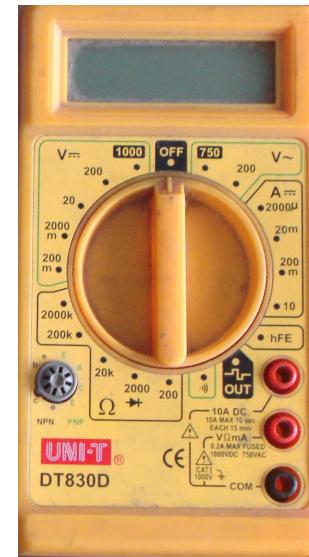
Georges Khaznadar, Science teacher & Debian developer.
Volunteers for PHOENIX Project

Project Objective

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



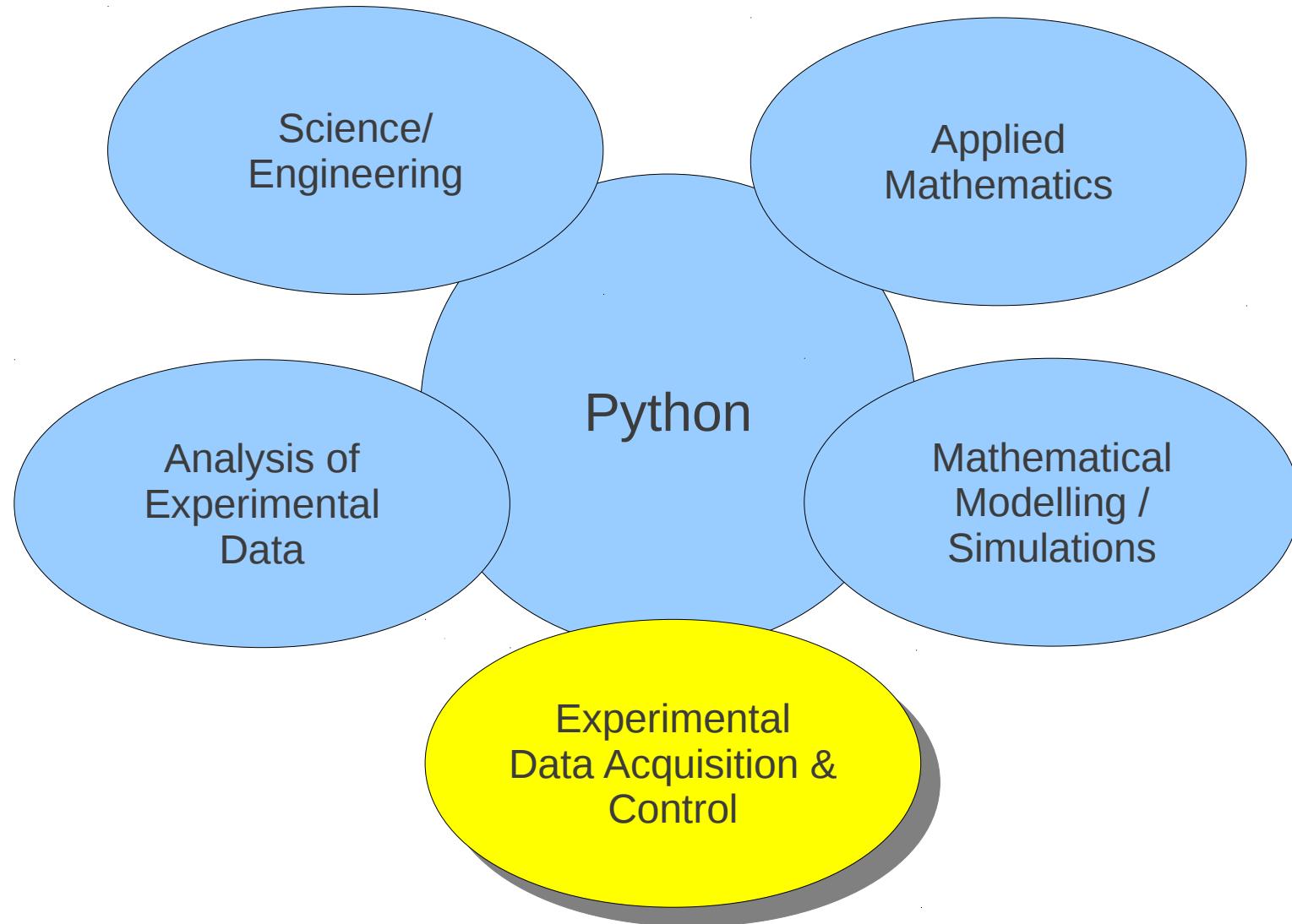
US\$ 30



US\$ 2.0

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

Role of Python in Science & Engineering Education



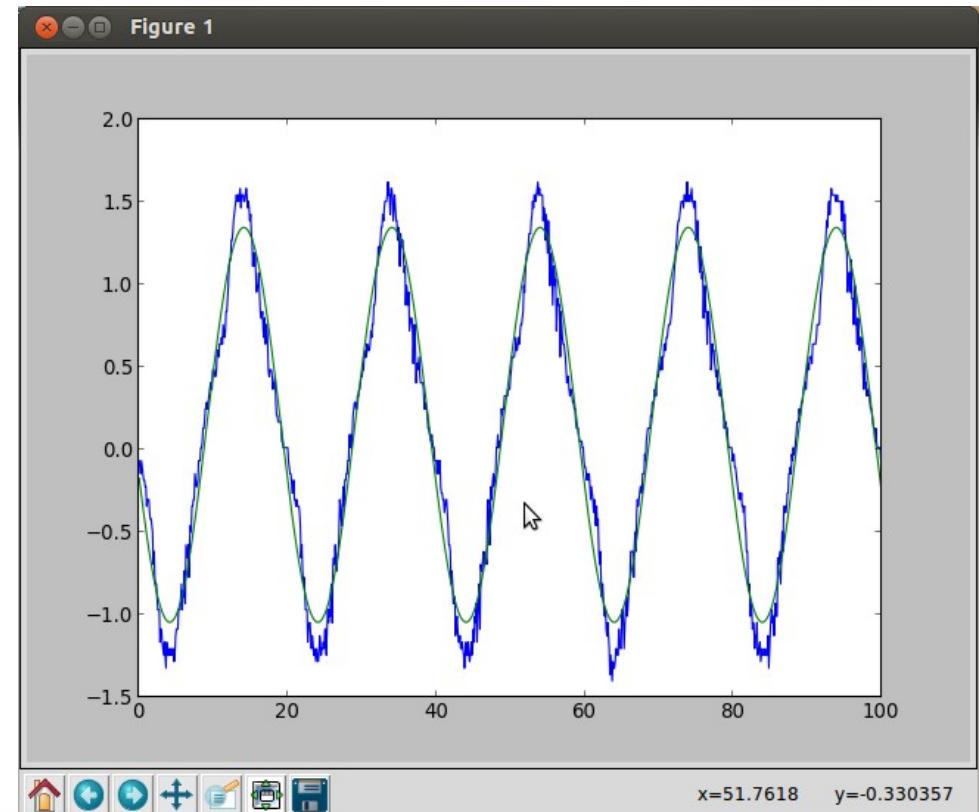
Data Analysis & Visualisation (AC mains pickup signal)

```
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
```



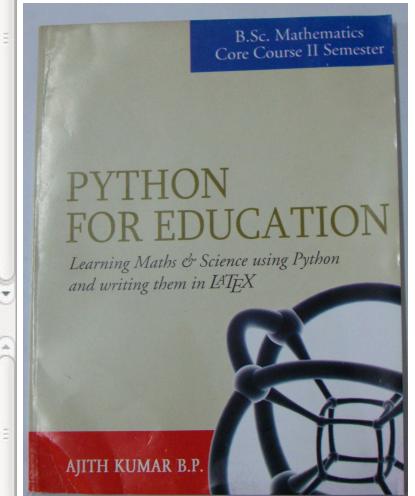
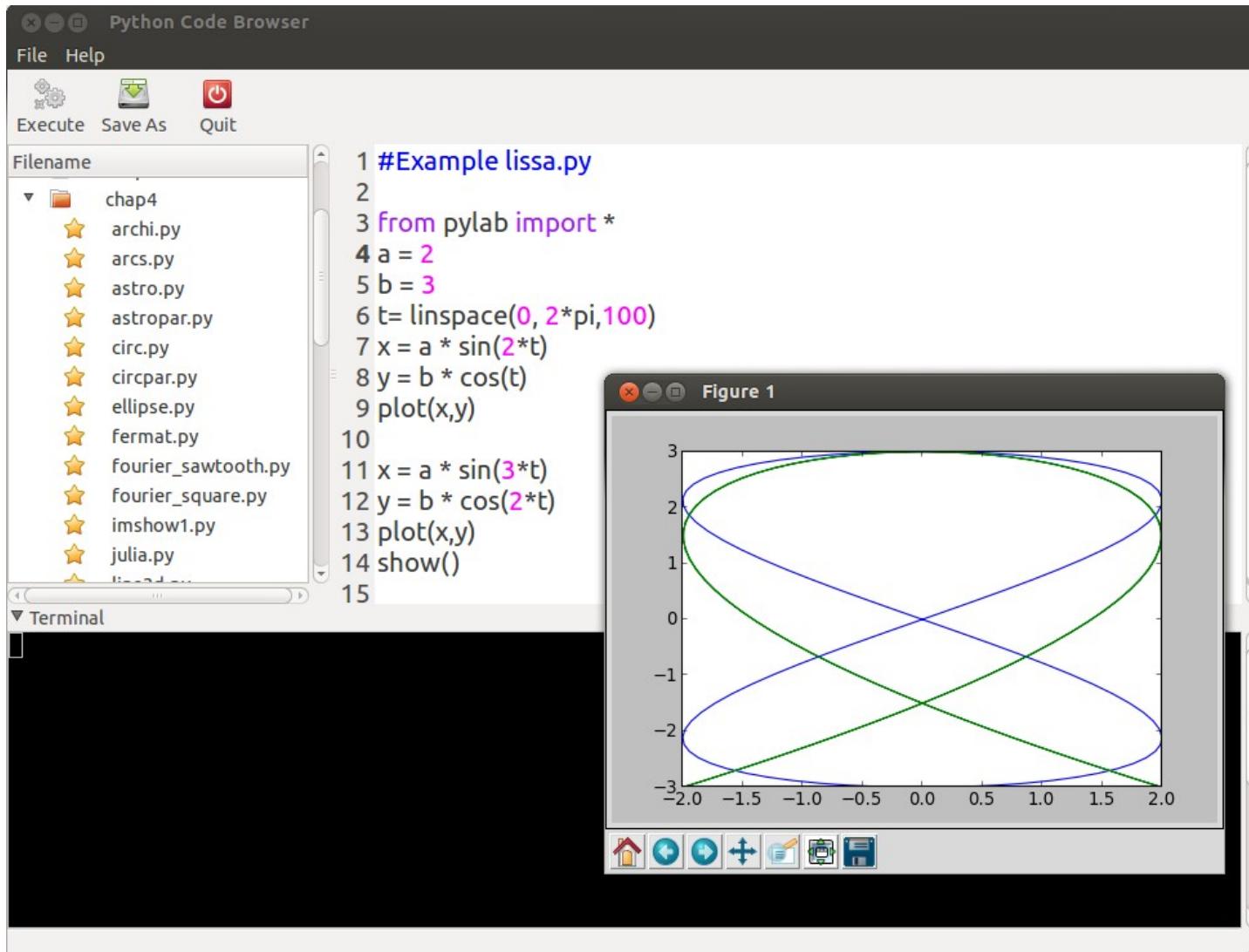
Attempts to include Python in the Syllabus

- 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



Python book
under GNU FDL

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

For details visit <http://expeyes.in>

The screenshot shows the homepage of the expEYES website. The header features the logo "ExpEYES ... Your Lab@Home" and the tagline "Low Cost Science Experiments using Computers". Below the header is a navigation menu with links to HOME, HOW TO BUY, MICROHOPE, SOFTWARE, PYTHON, and PEOPLE. A banner below the menu reads "Experiments for Young Engineers and Scientists". The main content area is titled "expEYES" and contains two images of the hardware. The left image shows the standard expEYES unit connected to a laptop, displaying a waveform on its screen. The right image shows the expEYES Junior unit connected to a laptop, also displaying a waveform. To the right of the hardware images is a list of product features: "A tool for learning science by exploration and experimenting.", "50 documented experiments and easy to add more.", "Wide range, High school to PG level.", "Built-in Signal Generator and CRO.", "USB Powered.", "12bit analog resolution.", "Microsecond timing resolution.", "Open Hardware & Free Software.", "Software in Python language.", "Compact, 8.6x5.8x1.6 cm, 60 gm.", and "Low Cost, 2 models available.". Below this list is a green link "[-- expEYES | expEYES Junior -->](#)". At the bottom of the page, there is a detailed description of the expEYES project, mentioning its origin from the PHOENIX project at IUAC, New Delhi, and its purpose as a framework for developing science experiments using Python and microcontrollers.

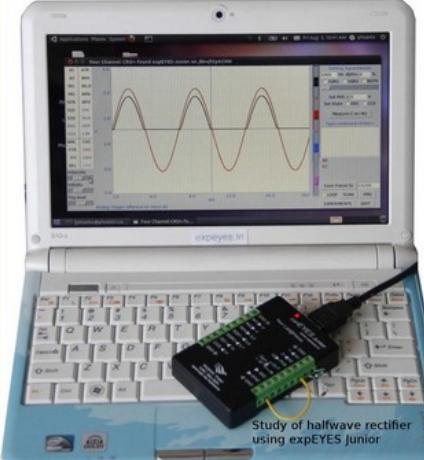
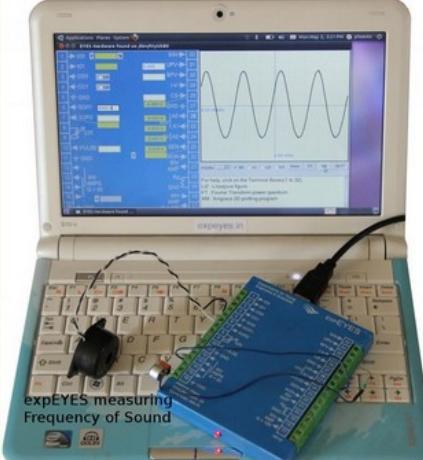
expEYES | ExpEYES ... Your Lab@Home

Low Cost Science Experiments using Computers

HOME HOW TO BUY MICROHOPE SOFTWARE PYTHON PEOPLE

Experiments for Young Engineers and Scientists

expEYES



A tool for learning science by exploration and experimenting.
50 documented experiments and easy to add more.
Wide range, High school to PG level.
Built-in Signal Generator and CRO.
USB Powered.
12bit analog resolution.
Microsecond timing resolution.
Open Hardware & Free Software.
Software in Python language.
Compact, 8.6x5.8x1.6 cm, 60 gm.
Low Cost, 2 models available.

<- expEYES | expEYES Junior -->

expEYES is from the PHOENIX project of Inter-University Accelerator Centre, New Delhi. It is a hardware & software framework for developing science experiments, demonstrations and projects without getting into the details of electronics or computer programming. PHOENIX (Physics with Home-made Equipment and Innovative Experiments) project was started, in 2005 as a part of IUAC's outreach program, with the objectives of developing affordable laboratory equipment and training teachers. Design of ExpEYES combines the real-time measurement capability of micro-controllers with the ease and flexibility of Python programming language for data analysis and visualisation. Software for all products from PHOENIX are distributed under GNU

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](mailto:sankar_systems@sify.com)

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

Mumbai

*Amit Dhakulkar
Ph : 9819350953
email : [damitr at gmail.com](mailto:damitr@gmail.com)*

S2S2 Services

*TV 33/268, Third Floor Elite Complex
Netaji Road, Kannur 670 001
Kerala
Ph: 9447449107
email : [s2s2service at gmail.com](mailto:s2s2service@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](mailto:vibsys_n_soft@yahoo.com)*

Sys-Con Engineering

*53B Mirza Galib Street
Kolkata 700 016
Ph: 9830417377 , 033 40014680
email : [sceskm at yahoo.com](mailto:sceskm@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](mailto:info@svtechnocrafts.in)*

Fab to Lab (Order Online)

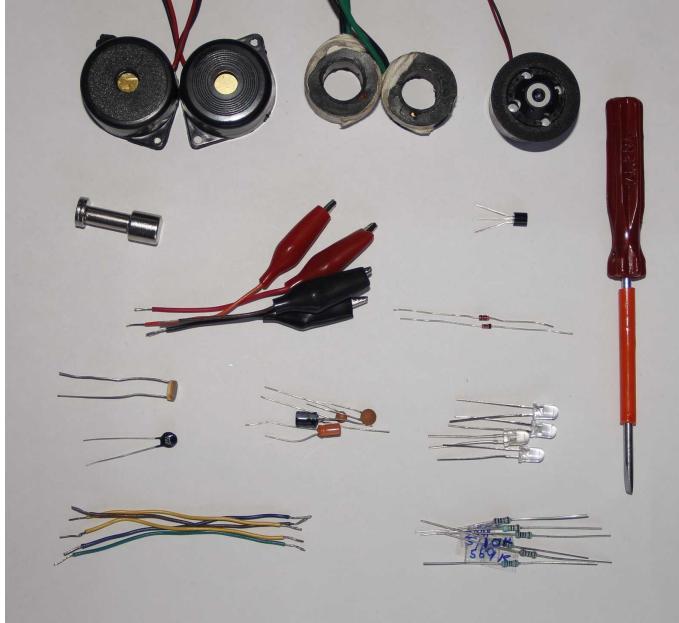
*#41, Pentagon Passiflora
Sarjapur, Bangalore - 562125
Ph: +91 80 95782777
email: [sales at fabtolab.com](mailto:sales@fabtolab.com)*

Open Hardware: Schematics & PCB files are on the website

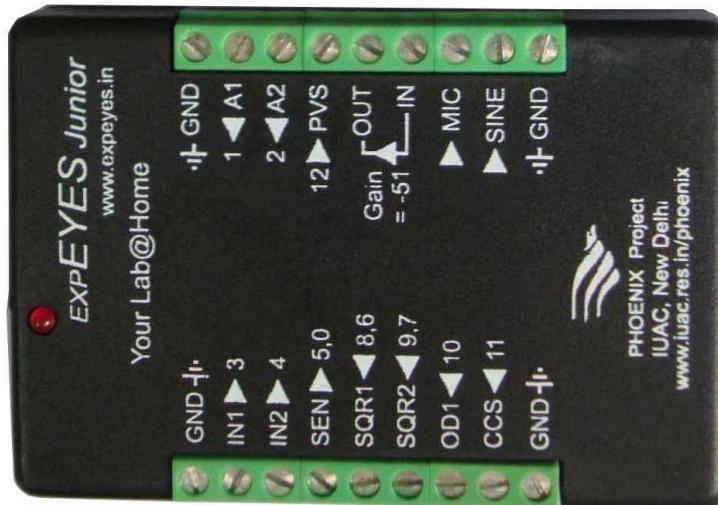
Software Distribution:

- 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/-

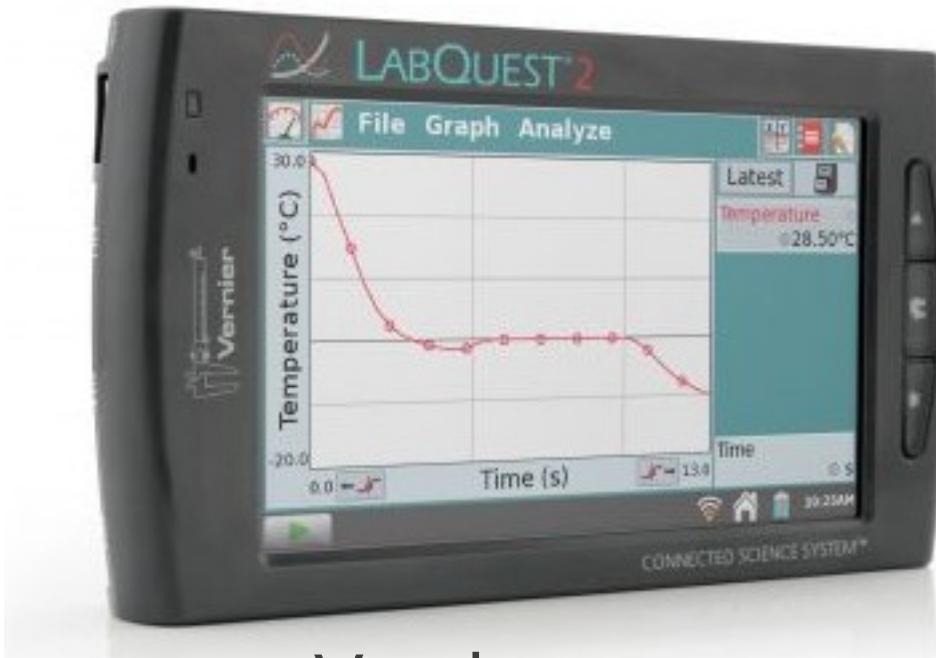


Interface + Standard Accessory Set + LiveCD

Other commercially available equipment providing similar facilities.



Pasco



Vernier

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

Thank You

