Introduction to Year 2 lab

The lab runs during the Autumn term, and consists of a collection of short experiments. The purpose of the experiments is twofold: to give students experience of some techniques of modern experimental work, and allow exploration of a variety physical phenomena. The techniques used will prove useful in the Spring term projects.

Times and pairs

Groups X, Y and Z each attend the lab for 6 hours per week, from the second week of term until Christmas. All experiments are done in pairs, so you will need to find a partner in the same lab group, preferably before your first lab session. There is no need to stay with the same partner throughout the term, if you can arrange an amicable swap with others doing the same experiments.

Experiments

The experiments are divided into three sections, D, E and O, as follows:

- **D: Data Acquisition**
  1. Non-ideal pendulum (automatic data acquisition, modelling, nonlinear fitting)
  2. Current-voltage characteristics (linear, nonlinear and hysteretic devices)
  3. Loudspeaker resonances (resonant modes, damping, physical modelling)
  4. Fourier spectrometry (data sampling, frequency analysis)
- **E: Electronics**
  1. Switch mode power supply (inductors, energy transfer, transients, resonance)
  2. Micropython microcontroller (embedded digital electronics, interfacing)
  3. Small signals (differential amplifier, interference, filtering)
  4. Servo control (digital negative feedback using PID, stability, damping)
- **O: Optics and other long**
  1. Properties of light sources (spectral and intensity variations, colour vision)
  2. Optical fibres (frequency and amplitude response, dispersion, speed of light in glass)
  3. Rayleigh scattering (light scattering, polarisation, photometry)
  4. Michelson interferometer (interference patterns, laser optics, precision measurement)
  5. Zeeman effect (precision measurement, atomic physics)
  6. *Efficiency of a Stirling engine (work done by a gas, elementary thermodynamics)**
  7. *Franck–Hertz experiment (atomic physics, data processing)**

  ** these experiments are not generally available, but consult the lab leader if particularly interested.*

Students rotate between experiments in a cycle as follows: choose an initial lab (section) at random, then circulate around the list E $\rightarrow$ O $\rightarrow$ D $\rightarrow$ E ..., spending two weeks in each area until the end of term. There is an almost free choice amongst O experiments, which each last two weeks. The one-week D and E experiments are normally done in pairs in the order shown: (switcher & microcontroller), (pendulum & current-voltage) in the first half of term, then (small signals & servo), (speaker & Fourier) in the second half.

It is therefore possible to predict which experiment you will be doing next, and read the manual in advance, a move that is strongly recommended. All the manuals are available via Canvas.

Marking

Assessment is based on the contents of your laboratory notebook. There is no formal report for this lab, *and your lab book is not meant to be written like one.* At the end of every experiment, you must hand in your lab book for marking - this means after **6 hours in data acq. and electronics, but 12 hours in optics** and other long. X group can hand in up to 2 PM on Tuesday, to compensate for not having an evening between sessions. The demonstrators will return your book at the beginning of the next lab session, and will discuss your work, and their *provisional* mark, with you. The head of the lab monitors all marking, and moderates rigorously any variations between markers and experiments.

Style of experiments

The experiments illustrate particular concepts and techniques, and the manuals therefore tend to start with a prescriptive section, followed by less detailed instructions for more advanced topics that you should pursue in your own way. The longer experiments give more time for the latter. It is up to you to organise your time to produce the most scientifically interesting results. Good ideas of your own are welcomed, and indeed necessary if you are aiming for high marks. The demonstrators will advise on your plans as the experiment progresses.

Attendance

You are expected to attend all your lab sessions for their full duration. If your attendance is patchy, or you take long breaks, you will have difficulty keeping up with the work. Absence from labs is treated the same way as absence from tutorials, and is something you must discuss with the senior tutor. It is important to remember that you must pass lab in order to enter the third year; moreover there is no summer resit for the lab.

Safety

Most of the experiments have been designed to have no special hazards. For those that do involve lasers, electromagnets etc., both the manuals and the demonstrators will draw your attention to safe procedures. In any case, consult the lab safety documentation, demonstrators or the technician if you are in any doubt, and especially if you are planning to diverge from the manual. If you bring any equipment from outside the lab, it *must* be checked by the technician before use.

Conduct

We expect a reasonable standard of professional laboratory decorum, so eating, drinking, horseplay and extensive socialising are not allowed in the lab.