Research Topics – Jonathan Scott

This page provides outline descriptions of (ENGEE/M.E./MPhil/PhD) research topics that I currently have available. If you are interested in one of these topics please contact me. I am willing to reserve a topic for a reasonable period while enrolment arrangements are made.

Projects do not come with any stipend or salary unless specifically stated otherwise.

- **DSP Approach to Noise Voltage Measurement**

  This is a 900-level (PhD) project, but could be a 500-level investigation to simply develop the hardware or test algorithms. Applicants for PhD should have an honours degree in EE and preferably a research masters. Experience with C-based microcontrollers and python would be advantages.

  This project involves the design of a noise characterisation system, and discovering the limits of such a system. The idea is to investigate the correlation method of measuring noise in the 1Hz to 20kHz range. What are the limits? What is required of hardware to achieve this? The topic is really about using low-cost (24-bit?) ADC converters with a small platform such as an ARM Arduino or rPi microcomputer to demonstrate noise measurement, and to elucidate the limits of what the correlation method can add to hardware with a given performance. The research question would be "how much better can the instrument be than its LNA would otherwise allow and what limits this in DSP terms". The application of such an instrument would be measuring FET Equivalent Input Noise Voltage (EINV), particularly on CMOS devices. Can engineers arbitrarily lower the system EINV by increasing memory, processor, and measurement time?

- **Passive Battery Model**

  This is a 900-level (PhD) topic. A research masters is required. Experience with python, VISA and SCPI would be an advantage.

  Recent work has suggested that rechargeable batteries can be modelled in their linear regions (20 to 80% SoC) using fractional capacitors (also known as Constant Phase Elements or CPEs) rather than voltage or current sources. This project will look at extending our passive battery model to the full-charge and near-flat regions. The intention is to achieve this with memristors modelling the depletion of chemical species. The aim will be to predict state-of-health as well as state-of-charge.

- **SPICE Model of a BC547**

  This could be a 400-level (Honours) investigation or a 500-level (Masters) project.

  The BC547 has been around a long time. A detailed SPICE model has been available for over 40 years, but the values do not seem to be consistent over time. This is likely to be a result of changes in the silicon fab technology. This project aims to obtain values on a single transistor for the majority of the SPICE parameters. A point of interest will be comparing them with values obtained in the 1970s.
Lithium-based Plug-in Replacement for Lead-acid Battery

This is a 400-level (Honours) project.

This project would suit an EE and an ME student working as a team. The aim is to replace two 12V, 30Ah, lead-acid batteries in an electric scooter with "boxes" containing a set of high-capacity Lithium batteries and a battery management system, to get something the same size but lighter, more powerful, and more energy-dense than the original batteries. The electronics in the boxes needs to make the replacement batteries look electrically just like lead-acid cells. The performance (size, weight, capacity, safety, maximum current, etc) and cost of the two alternatives will be compared and the results written up in a manuscript for publication. The student(s) undertaking this project will have use of my eGo scooter and given the time will be expected to measure changes in its performance "before" and "after" as well.