Research Topics - Jonathan Scott

This page provides outline descriptions of (ENEL/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.

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- **DSP Approach to Noise Voltage Measurement**

  This is a 900-level (PhD) project, but could be a 400- or 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, as would familiarity with discrete cross-correlation.

  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?

- **Cuk Converter as a Fast Pulsed Current Source**

  This could be a 400-level (Honours) investigation to develop a prototype hardware platform, a 500-level (Masters) project, or a 900-level (PhD) if taken to the full extent of charge-pump control. Experience building circuits on PCB would be an advantage.

  The Cuk converter is a popular buck-boost configuration for switchmode power supplies. It is usually used to convert one voltage level to another, and has been described as a "dc transformer". A high-efficiency switchmode replacement for an analog current source is required to deliver known amounts of charge, rather than current or voltage. This project aims to explore the use of a Cuk circuit as a current source and charge pump, and maybe demonstrate a prototype based on the Cuk topology. The source must deliver up to 15mA into a load of typically 500 to 2000 Ohms from a 3.3V supply. It needs to deliver this current for 50 to 500 microseconds, delivering no more than 10uC with a resolution of 50nC or better, under the control of a small microcontroller. Is it simple to pump known charge with a Cuk circuit? How should component values be chosen to achieve the resolution?

- **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.

- **Kickstarter Pitch**

This is a 400-level (Honours) project. This project would suit a small team (2 to 5) students, at least one of whom should be an EE.

From a previous, very successful, project, we have the plans and code for a plug-in upgrade to Scalextric slotcars that installs the equivalent of anti-skid stability systems on real cars. The team will build a number of these then put together an offer on Kickstarter, including manuals, promotional video, etc.

- **Solar Panel Quality Assessment**

This is a 400-level (Honours) project. This project would suit one or two EE students.

The quality of a solar panel, particularly one designed for power harvesting rather than grid use, turns out to be captured no so much by its peak conversion efficiency, but by the variation of that efficiency with the intensity of insolation. (See "Low Light Performance of Mono-Crystalline Silicon Solar Cells", Bunea et al., IEEE 4th World Conference on Photovoltaic Energy, 2006.) In this project you will construct a light table capable of delivering from 0.001 sols to 1.0 sols to an area of about 130mm square, calibrate it, and measure some cells to determine their efficiency curves and maximum efficiencies.

- **Lithium-based Plug-in Replacement for Lead-acid Battery**

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.

- **Replacement of BDC Motor with a PMS Motor**

This is a 400-level (Honours) project. This project would suit an EE and an ME student working as a team.

Brushed Direct Current (BDC) motors, and especially the ubiquitous "can" type of motor, are very common in low-cost applications such as toys, window-winders, small tools, small appliances, etc. The advent of low-cost disk drives, starting with floppy disks in the 1990s, and the relentless drive to
make them cheaper and cheaper, has lead to BrushLess DC (BLDC) or Permanent-Magnet Synchronous (PMS) motors that are approaching being as cheap as the BDC type. These are now found in cooling fans and drones as well as disk drives. Many systems now have these motors designed into them instead of BDC types.

PMS motors tend to have a higher power-to-volume than BDC motors. This project will demonstrate the possibility of replacing a BDC can motor with a smaller PMS motor, as a plug-in replacement, by putting both the drive electronics and a PMS motor in the can of a PDC type. The practical outcome is the ability to obtain the long life of a PMS motor in a system using a BDC motor design. I envisage a publication with a title something like "Retrofitting Vintage Models' BDC Motors with Reliable AC Synchronous Motors".