ENEL 372 - POWER AND ANALOGUE ELECTRONICS 1

25% Assignment

# Model Solar Powered Car

The model solar car comprises a 10W solar panel mounted on an aluminium chassis. Also mounted on the chassis are a dc motor, gearbox and servo. **ONLY** the servo (for steering) may be powered from an auxiliary battery source. You are not allowed to alter any mechanical characteristics of the car. The car requires design and build of electronic hardware to make the dc motor run from the solar panel.

**Project Description**:

1. Complete some introductory lab exercises
2. Carry out an investigation to determine the solar panel and dc motor characteristics and hence determine a suitable design strategy.
2. Design and build a buck converter to interface between the solar panel and the dc motor. A breadboard can be used for initial circuit testing, but the final circuit must be mounted on vero-board or a printed circuit board.
3. Test your vehicle to determine its performance. The vehicle must be able to start moving under its own power as soon as sunlight falls on the panel. Performance will be assessed over a race of about 10 metres.

**Design constraints**:

1. A buck converter circuit should be used.
2. Control chip must be the TL494.
3. N-channel MOSFET IPP034N03L should be used.
4. Diode SB240S should be used.
4. Inductor core is of type RM8. You have to wind this yourselves.
5. Maximum capacitance in the circuit is 350 μF

**Project Support:**

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| People: | Edsel Villa is based in the Power Electronics lab, and Teaching assistants will be available in the Electrical Machines lab, times to be advised. |
| Labs: | Three lab exercises that are very useful for this project are the TL494 lab, the buck converter lab and a BJT transistor lab. These will run in the Electrical Machines lab on dates below. Book yourselves in on the Machines lab door. |
| Tutorials: | I will run 2 or 3 tutorial/lectures to help get you going. |
| Components: | Semiconductors, inductor cores, and most other components you need are available from Edsel Villa in the Power Electronics lab. Other components are available in the ECE store. |
| Tools: | Each group must have their own basic set of tools (side cutters, set of screwdrivers and pliers). Soldering irons and other specialised tools will be provided. |
| Benches: | Benches with power supplies and oscilloscopes are available in the Electrical Machines lab. Do not spread beyond these benches or take equipment from other benches. The Power Electronics lab will also be available during the August break. |
| Test rigs: | Solar panels and dc motors are available for testing in the Electrical Machines Lab. |

Practical work (laboratory investigations, design and testing) is to be carried out in groups of 3.

**Schedule**:

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| Friday 30 July: | Nominate your groups. Three people per group.<br>Email your nomination to alan.wood@canterbury.ac.nz |
| Monday 2 August: | First day components are issued and lab made available. |
| Friday 27 August (or earlier) | Open Loop LTspice simulation circuit submission. (2%) |
| Tue/Wed/Thu 28/29/30 Sept: | Group Lab review (10%). |
| Mon 4 October 5.00pm: | Group Design Report (15%). |
| Tue 5 October: | Self and Peer assessment |

**Introductory lab exercises:**

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| Mon 2 August: 3-5 | PWM & BJT lab |
| Tue 3 August: 12-2 | PWM & BJT lab |
| Wed 4 August: 11-1 | PWM & BJT lab, Buck Converter lab |
| Wed 4 August: 3-5 | PWM & BJT lab |
| Thur 5 August: 9-11 | Buck Converter lab |
| Fri 6 August: 11-1 | Buck Converter lab |
| Mon 9 August: 3-5 | Buck Converter lab |
| Tue 10 August: 12-2 | Buck Converter lab |

Race day, weather and other assessment dependent:

A bonus mark of up to 5% will be awarded to all members of the same group for their car's performance on race day.

1% - car moves more than a metre after an initial push
2% - car completes one of the race heats with fewer than 3 pushes
3% - car completes one of the race heats without assistance
4% - car gains 1st or 2nd place in race heats
5% - car gains 1st or 2nd place in final race

The **lab review will take place in the Power Electronics Lab**. You must bring a spare copy of your circuit diagram and your design notes to the lab review. I will keep your circuit diagram as a memory aid when assigning marks. A power supply may be used as substitute for the solar panel and a solar car motor will be connected as a load. The marking schedule for the lab review will be based around the following sorts of questions and all members of the same group who attend and participate will receive the same Review mark:

- Explain how you achieve the power supply for your PWM chip.
- Demonstrate how the control signal interacts to change the pulse width.
- Demonstrate the gate signal driving your power MOSFET(s).
- Demonstrate how the gate signal changes with mechanical load.
- Demonstrate the current waveform through your inductor.
- Explain the principle of operation of your control system.
- Demonstrate that you can develop torque on a loaded motor

Note: You should provide loops on your board so that a current probe can easily be inserted to measure inductor current.

**Your report must be a group report**, which should include all aspects of the design, operation and overall performance of your converter. There will be a late report penalty of 10% per day, unless otherwise pre-arranged.

You must submit by email ratings (out of 10) of your own contribution and the contribution of each member of your team, and a very short summary of all the individual contributions to the project. This will be used to scale 30% of the group project mark.