Electronics Topic: Design Tasks 1-3

Preliminary Notes

The Electronics Design topic in this subject is spread over 3 weeks, with laboratories in Weeks 1, 2 and 3. This handout introduces the first 3 of 6 design tasks within this topic. The remaining design tasks will be released according to the schedule that appears on the course web-page at http://subjects.ee.unsw.edu.au/~elec4123.

Your performance in these design tasks will be assessed in the laboratory, although your participation in tutorial discussions will be separately assessed (worth a total of 20% over the duration of the course). The laboratory component of your assessment for the electronics design tasks as a whole is worth 17% of the marks for the course. As indicated in the course overview, this is composed of 10% for design outcomes and 7% for understanding. To simplify the awarding of marks, these percentages are multiplied by a factor of 5. This means that there are a total of 50 marks for design outcomes in electronics and 35 marks for design understanding in electronics. An individual breakdown of the maximum marks available for each task is provided in the following. However, these individual figures may add up to more than a total of 85 marks. Where this happens, your overall mark in the electronics design topic will be capped at 85.

Note carefully that your breadboard **may not be populated prior** to any laboratory session – demonstrators will insist upon this. Also, you may not bring any notes into a laboratory session other than printouts of materials from the class web-site and **written notes from a previous laboratory, duly signed off in your laboratory notebook.**

You will, however, be **permitted to take your populated breadboard** and any electronic components which you have used out of the laboratory, for your own independent experimentation. However, components must be signed off by the demonstrator and you must bring these same components back to the laboratory the following week, together with an unpopulated breadboard.

Sharing Equipment and Communication in the Lab

Due to current resource constraints, you will generally share a work bench in the laboratory with a lab partner. Despite this, your design, implementation and assessment for these tasks are all individual. Naturally, you cannot expect to have your design permanently tethered to the power supply, oscilloscope, signal generator or other laboratory equipment. You should, therefore, communicate with your lab partner and establish a good working relationship for sharing the equipment.

Although assessment is individual, you can communicate freely with your lab partner regarding the design problem. There is no expectation that your partner should help you with the construction of preliminary testing of your design, but this is permitted so long as you both agree.

Apart from communication with your lab partner and the lab demonstrators, you should avoid any significant communication with other students in the lab. **Demonstrators have full authority to clamp down on unnecessary communication**, including by moving troublesome students to the end of the assessment list, which may delay assessment until a following week – you will find that being assessed early is very important for success, especially since you are not permitted to bring assembled solutions into the laboratory.

Assessment Procedure

Demonstrators will maintain an ordered assessment list. You may not add your name to the list until you have a solution you are prepared to have assessed. Students who have already been assessed for a task may have the opportunity to be re-assessed, during the same or a later laboratory session, but students who have not yet been assessed will be given priority over those seeking re-assessment.

Demonstrators may ask you to move to a separate area for assessment, so that your lab partner need not be disturbed. With this in mind, you should ensure that your implementation is as portable as possible, so that you can easily connect it to a separate power supply, signal generator and/or oscilloscope, as appropriate.

Electronics Design Task 1

In this design task, you are to design an electronic circuit which provides a voltage source whose open-circuit voltage is $V_0 = \alpha V_S$, where $\alpha<1$ is a constant that will be given to you in the laboratory and V_S is the supply voltage of a single-ended power supply; this value will also be given to you in the laboratory. In practice, you will use the laboratory power supplies to set up V_S. The voltage source that you design must have an impedance of no more than 20Ω and must be able to handle short circuits without exceeding component ratings.

It should be apparent to you that even this simple design task has multiple solutions. You should be prepared for the fact that α may be close to 0 or close to 1 and so come prepared to your laboratory to address any such eventuality.

In addition to the hard requirements, which are stated above, design problems usually have soft objectives which are desirable to optimize. For this particular design task, your soft objective is to design a solution which wastes as little power as possible. You are not required to come up with a truly optimal solution in this regard, but the laboratory demonstrators will ask you to show what you have done to address this objective. To this end, you are strongly advised to come up with at least two different design approaches and to understand and/or measure the power efficiency of each approach.

Available Electronic Components (on hand with your lab demonstrator):

Transistors: BC549, BC559, BD139, BD140
Analog IC's: LM324, LM348, LM741
Diodes: 1n4148
Resistors and capacitors, as found in the laboratories

Assessment for this task:

Marks for this task are as follows:

- Achievement of requirements: (____/6)
- Steps taken to address power efficiency: (____/2)
- Understanding and neatness of the breadboard layout: (____/5)

Weeks in which this task may be completed:

You may complete this task in any of Weeks 1, 2 or 3. However, the parameters α and V_S will generally change from week to week, which may possibly require you to modify your design approach.

Electronics Design Task 2

In this design task, you are to design an amplifier which adds two input voltages together and amplifies the sum of their voltages by an amount G. The designed circuit is required to have input impedances of at least 10kΩ and an output impedance of at most 1kΩ. The range of input voltages to be handled and the value of G will be given to you at the start of the laboratory. In addition to these requirements, the amplifier is to have achieve the desired gain within 3dB, over a range of frequencies from f_L to f_H. These lower and upper frequencies will be given to you at the start of the laboratory. Moreover, the DC gain of the amplifier is to be 0.

It should be apparent to you that the required gain and the required frequency ranges should have an impact upon the design.

Some parameter values may require a more complex design than others. For this task, your soft design objective is to come up with a simpler solution, wherever this is possible.

Available Electronic Components (on hand with your lab demonstrator):

Transistors: BC549, BC559, BD139, BD140
Analog IC's: LM324, LM348, LM741
Diodes: 1n4148
Resistors and capacitors, as found in the laboratories

Assessment for this task:

Marks for this task are as follows:

- Achievement of requirements: (____/7)
- Elegance (i.e., simplicity) of the design: (____/2)
- Understanding and neatness of the breadboard layout: (____/5)

Weeks in which this task may be completed:

You may complete this task in any of Weeks 1, 2 or 3. However, the parameters G, f_L and f_H will generally change from week to week, which may possibly require you to modify your design approach.

Electronics Design Task 3

In this design task, you are to design a comparator with hysteresis. The input impedance of your compator should be at least 100kΩ and the output of the comparator should have only two stable states, corresponding to zero load output voltages of V_H and V_L, with an output impedance of no more than 1kΩ. The output voltages V_H and V_L will be given to you at the start of the laboratory session. Your comparator should be designed to exhibit a hysteresis of V_T, the value of which will also be given to you at the start of the laboratory session. You should make absolutely sure you know what hysteresis is before attempting this design task.

As with all design tasks, you should feel free to discuss possible solutions within your tutorial group. As noted in the class handout, participation of this form within tutorials is ultimately worth a total of 20% of your assessment for this subject.

A natural soft design objective for this task is to maximize the switching speed of the comparator. You may receive bonus marks from the laboratory demonstrator if you manage to demonstrate a solution which has unusually high switching speed.

Available Electronic Components (on hand with your lab demonstrator):

Transistors: BC549, BC559, BD139, BD140
Analog IC's: LM324, LM348, LM741
Diodes: 1n4148
Resistors and capacitors, as found in the laboratories

Assessment for this task:

Marks for this task are as follows:

- Achievement of requirements: (____/7)
- Bonus marks for switching speed: (____/2)
- Understanding and neatness of the breadboard layout: (____/5)

Weeks in which this task may be completed:

You may complete this task in any of Weeks 1, 2 or 3. However, the parameters V_T, V_L and V_H will generally change from week to week, which may possibly require you to modify your design approach.