Electronics Topic: Design Task 6

The Electronics Design topic in this subject is spread over 3 weeks, with laboratories in Weeks 1, 2 and 3. This handout introduces the final design task within this topic, namely task 6.

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. 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 6

In this design task, you are to design a frequency multiplying circuit. The circuit should produce an output voltage waveform which is periodic, executing exactly D cycles for every cycle of a periodic input waveform; in other words, your output signal must be synchronized with the externally supplied input signal. The value of D is an integer which will be given to you at the start of the laboratory session. For the purpose of testing, the input signal that you will work with may be generated using one of the signal generators in the laboratory. Your circuit must have an input impedance no smaller than 1kHz and be able to work with any input signal whose peak-to-peak voltage is in the range from 0.5V to 2V and whose fundamental frequency lies in the range 2 kHz to 3 kHz.

Your circuit does not necessarily have to work with any arbitrarily shaped input waveforms. In fact, you are free to design a circuit which works only with square wave inputs, only with sinusoidal inputs, or only with triangular wave inputs, as these are the waveforms you can readily obtain using the laboratory signal generators.

As with all the design problems, there are many solutions, which may look quite different. You are strongly encouraged to discuss the design requirements and possible solutions in your tutorial group.

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 objectives are: 1) your design should aim to produce a circuit which works correctly with a wide range of periodic signal waveforms, including those which have complicated harmonics; 2) your designed circuit should be able to adapt as quickly as possible to changes in the input frequency and phase – if you intend to pursue this objective, your circuit should provide an LED which is illuminated when the circuit is locked to its input; and 3) your circuit should be as robust as possible to the presence of noise or other sources of interference in the input signal. Some of these soft objectives have the potential to push your design in different directions. For example, a circuit which is highly immune to noise and interference might not adapt quickly to changes in the input frequency or phase. You should refer to the marking scheme when balancing competing objectives. You should be prepared to justify claims you make in regard to these soft objectives.

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

Transistors: BC549, BC559, BD139, BD140
Analog IC's: LM324, LM348, LM741, DG441/2
Digital IC's: 74LS00, 74LS74, 74LS86, 74LS123, 74LS161/3
Diodes: 1n4148
Resistors and capacitors, as found in the laboratories

Assessment for this task:

Marks for this task are as follows:

- Achievement of basic requirements: (____/10)

- Reasonably insensitive to waveform shape: (____/2)
- Has locking LED (more points if it can adapt quickly): (____/4);
- Robust to noise and interference: (____/3)
- Understanding and neatness of the breadboard layout: (____/10)

Weeks in which this task may be completed:

You may be assessed for this task only in Week 3.