A First Lab in Circuits and Electronics 1st edition Tsividis Solutions Manual

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INSTRUCTOR'S MANUAL

version 1.1

to accompany the book

"A FIRST LAB IN CIRCUITS AND ELECTRONICS'

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INTRODUCTION

This manual is meant for those instructors who have already adopted the book for their lab. A companion manual entitled **"Putting the Lab Together"** is freely available on the Web, and provides a large amount of information meant to make setting up a lab like this easy. Information about dealers who are supporting this lab is also given there.

Please feel free to contact me if you need some suggestions as you prepare a lab based on my book. My e-mail is tsividis@ee.columbia.edu.

RUNNING THE LAB

Hints For Choosing Teaching Assistants For This Lab

In some colleges a lab such as this is run by faculty. The following guidelines apply in the case where the lab is intended to be run by teaching assistants instead.

When I try to find TAs for this lab, I advertise the required qualifications as follows:

- Excellent, working knowledge of electronic circuits and circuit analysis. Having taken courses in these areas some time ago is not enough by itself - you need to have truly working knowledge of circuits, as opposed to hoping that you can "remember the stuff". You need to have both analytical skills and intuition. Do not let the fact that this is a beginning lab fool you as to the skills needed on your part.

- Excellent laboratory skills - hooking up circuits from diagrams, de-bugging circuits of others, measuring. Hobby experience, or otherwise extensive experience with laboratory work, is a plus.

If you would like to include projects in the lab, you may want to add "Skills in designing and building original projects" to the qualifications advertised above.

As you may be painfully aware, the circuits knowledge of most of today' s students leaves much to be desired, so it is difficult to find appropriate teaching assistants for a circuits and electronics lab. This is especially true of the *first* circuits and electronics lab, where beginners may need careful explanations. It is even more true if projects are included in such a lab.

One cannot assume that, just because a graduate student has successfully taken all required circuits and electronics classes in an EE curriculum, including lab courses, he/she will be suitable as a TA for this lab. Successful running of this lab requires an active understanding of practical issues, and an intuitive feel for how circuits work. Over the years I have, not surprisingly, found that the most suitable TAs for this lab are grad students in the circuits area, and ideally Ph.D. stu-

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dents in circuit design. The next best bet is undergraduates who have already taken this lab with high marks. These are often better, for the purposes of helping with this lab, than graduate students in non-circuits areas. Invariably, each year I end up with a mix: A circuits Ph.D. student is the Head TA, another graduate student is a second TA, and the two are complemented with two or three undergraduate lab assistants.

I strongly suggest *not* to base selection of TAs on their transcript. I give each candidate for a TA position a short interview. I may ask them to draw a resistive voltage divider driving a capacitor, and to plot the output when the input is a step. If they do not realize that the time constant involves the parallel combination of the two resistors, their theory may be rusty. Next, I ask them some basic electronics questions, e.g. to draw the schematic of an inverting or noninverting amplifier using an op amp, and explain how it works. I ask them to select the resistors for a gain of 100, and then ask them what the output is for a 1 V input. If they answer that the output is 100 V and never worry that this is above an IC op amp's power supply voltage, they may be good with equations rather than real electronics. I then take them to the lab, give them a test board and cables, and ask them to hook up a simple circuit (even as simple as a voltage divider) and power it up. I observe how confident they are in doing this. Then, I ask them to measure a voltage from a specified point to another point, and observe how careful they are with the connection of the red and black terminals of the voltmeter. I may ask them to also measure a current in a specified direction. Finally, I ask them to hook up the function generator to the scope, and display, say, three cycles of a 1 V, 800 Hz waveform. I observe how careful and systematic they are in setting up the controls (even though they may not have encountered before the specific instrument models in front of them). Some students will inspect the instruments' face, think, and hit the right button; this is a good sign. Others may just keep turning knobs at random until something works. Of course, I vary the above tests from student to student and from term to term.

The results of a simple interview such as the above are often startling: Graduate students who have gone through standard EE curricula as undergraduates, both in the US and elsewhere, and who have high grade point averages etc., can fail miserably these simple tests. This may indicate that they would need too much preparation time to do their job right if hired as TAs for this lab. Given a graduate student's busy schedule, I usually cannot count on them actually spending this preparation time, and I look for somebody else.

Finally, if you plan to include projects in this lab (see corresponding sections below), then even some of the students who can pass the above tests successfully may not be adequate as TAs. Ideally, you need circuits types who also have some electronics hobby experience, but these are rare. You can ask colleagues who supervise circuits students to suggest ones suitable for supervising projects. If you cannot find people with adequate qualifications but you still want to include projects, you may have to limit the choice of projects to ones well-tested, like those described in the project sections below.

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