Manual for Electrical Network Analysis Laboratory EE3101

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Preface

The laboratory may well be the most important part of your education as an engineer. It is there that you will learn the power and the limitations of the theories that you study in class. It is also here that you will test your ability to translate theory into practice.

Remember, the practice of engineering does not simply involve writing equations and solving them. In most cases, the practice of engineering will involve taking theories that you have learned and translating them into tangible, practical, safe, economic device or system to meet the needs of your client and ultimately to meet the needs of society. It is in this laboratory that you will first begin to learn and understand what is involved in the design and realization of a physical system. I urge you to make the most of this opportunity because, ultimately, you will most likely be engaging in very similar activities for the majority of your career as an electrical engineer.

Let me first explain the main goals of the engineering circuits' laboratories.

1. You will first build physical models of the circuits and networks that you study in your electrical engineering courses, and you will test your understanding of how these circuits and networks operate by comparing your experimental results with the results predicted by the theories you have studied. You will also learn how to use computer based simulation models such as PSpice to validate circuit models.
2. You will learn that in many cases the theories that you study are highly idealized. As an example, a common resistor does not always give you a linear relationship between voltage and current at the terminals. This is a function of temperature, frequency, and the voltage that you apply to the terminals, and other phenomena that are often neglected in the first mathematical models of a resistor presented to you. You will begin to understand that the theories that you study represent mathematical approximations to reality. You must understand the limitations of those approximations.
3. You must learn to record your experimental work in a careful, systematic, and verifiable manner. You, or your employer's, legal claim to any invention or new engineering practice that you develop is ultimately based on how carefully and thoroughly you record your work and document your contribution. This is the place to begin to learn that habit.
4. No matter how good an idea you may have in the future, if you cannot present it succinctly and effectively both in written and oral form, nothing will ever come of it. As a professional, you will be expected to write clear, concise, accurate reports of all your work and to present them to your employers or your clients. One of the objectives of this course is to require that your laboratory reports begin to reflect the care in communication that will be expected of you when you graduate.

Enjoy your experience in the laboratory. take it seriously, since this is the foundation for all subsequent laboratories and for your ultimate practice as an engineer.

W. P. Osborne

Ericsson Professor of Electrical Engineering and Dean.

1 The Preliminaries.

Before you begin your laboratory experience here at UTD, you should be aware of what you are facing. There are objectives to strive for, concepts to grasp, and rules to follow. In this part of the manual, we try to point the way with a short description of what will be expected of you.

Remember that you are here to learn. You should freely aske questions of your instructors, but we expect you to be ready to do your own research into the phenomena that you observe in the laboratory.

1.1 A Short Laboratory Manual

FORMAT: Laboratory sessions last 3 hours, during which time the instructor will deliver directions for the current experiment, check notebooks for preparatory work, and return prior lab reports. the student will be expected to be prepared and to perform each experiment in the time allotted.

GRADING: Each week the student will prepare for the experiment and then perform the experiment. The following week you will turn in a report on the experiment. Your performance at each of these tasks will figure into the grade you receive for this course.

There are two types of reports, formal and informal. The format of these reports is explained below. Formal reports are graded from 0 to 100 based on content and presentation. Informal reports are weighted less than formal reports, and graded on a letter grade basis. To obtain a grade of A (excellent), a near perfect lab execution and write-up are required. The data taken during the lab must be reasonable, the student must indicate comprehension of the principals being taught through that experiment, and the write-up must be neat, clearly presented, accurate and complete. To obtain a grade of B (good), the overall lab execution and write-up must still be solid, but perhaps fall short on one or two of the above criteria. A grade of C (fair) indicates that the overall effort is acceptable, but clearly needs improvement. A grade of D (poor) or F (bad) is assigned to unacceptable efforts.

You will be required to do one formal report; it will be given weight equal to three informal reports in your grade. In general, the analysis section of your report will be worth 50% of your grade on that report. Other sections will be given weights appropriate to the experiment. Since the impression an engineer makes through writing is important, you will lose points for poor grammar, spelling errors and unclear writing.

Lab reports will count for ~~100%~~ 80% of your grade. Late assignments, missed experiments, improper preparation and other problems will show up as a penalty on the report for the affected experiment.

LATE REPORTS: Reports for an experiment are due before the laboratory session for the next experiment. Report that are late by less than one week will be penalized 30%. No report will be accepted that is more than one week late!.

ATTENDANCE: Attendance will be checked in each laboratory. No credit will be given for any report submitted by a student who was absent during the assigned laboratory session without a valid excuse. If an absence is unavoidable, students should contact the laboratory instructor to arrange another time to perform the experiment.

LAB NOTEBOOKS: You must maintain a bound laboratory lab notebook in which you will keep preliminary notes and calculations, details of experimental procedure, all recorded data, and brief analyses of experimental results. Your notebook will be checked every week and will be part of your score.

To be acceptable, a notebook must be bound, and it must be of the type that allows you to make a removable carbon copy of each page as you write in the notebook. Such notebooks are available in the UTD store (one style is known as a "computation" notebook).

Every week, before you leave the lab, you must turn in to your instructor the carbon copy of your data and observations. Your report will not be accepted if you fail to do this or if the data you turn in does not match that used in your report.

LAB PARTNERS: You will be assigned to work with one or more partners each experiment. All partners are expected to take an active part in preparation for and execution of each experiment. Each partner in a group is responsible for a separate and full report on each experiment.

1.2 General laboratory safety rules:

Low voltage electric and electronic circuits are seldom dangerous by themselves, but any work in a laboratory offers many opportunities for injury and damage to instruments. The Following safety rules have been established as a guide to safety and comfort; other rules as determined by individual instructors may also be in effect. At all times, you will be expected to use common sense to avoid endangering yourself or your partners. You are responsible for damage to any circuit or instrument.

1. Follow all instructions from your lab instructor.
2. no smoking, food or drinks are allowed in the lab.
3. Wear comfortable clothing. Avoid long sleeves and ties, synthetic fabrics, and silk garments (these are severe static discharge hazards). Shoes are required; they are important to your safety as they protect against electrocution and dropped tools.
4. Children are not allowe in the lab **UNDER ANY CIRCUMSTANCES.** If you have children, you mus make arrangements for them elsewhere. Children will not be allowed to wait for their parents outside of the lab without continuos supervision.
5. Remove rings and other metal jewelry that could contact the circuit. This may save your life!.
6. Check all test circuits before applying power. Look for short circuits, components installed backwards, or underrated components. Circuits built on prototyping boards are specially prone to errors due to the many opportunities for component leads to cross each other.
7. Use safety features (such as current limiting power supplies) whenever they are available.
8. Always ”smoke test” a circuit before attaching instruments. Check the current drawn from the power supply to make sure it is reasonable.
9. Never attach instrument probes to a circuit before the probes are attached to the instrument and the instrument is powered up. otherwise, you may damage the instrument.
10. Most instruments have both an active or ”hot” lead and ground lead (for example, an oscilloscope has a probe tip and a ground clip). Make sure that you do not form a short between two or more distinct nodes of your circuit by connecting instrument ground leads to different nodes. This may damage your instruments as well as change the circuit you are trying to measure.
11. When using line voltage or other sources of potentially lethal electrical power, always disconnect leads (plugs) from the high voltage end first. never hold high voltage leads in both hands; keep one hand behind your back when working on a circuit that is energized at dangerous potentials.
12. Even low voltage DC supplies can be dangerous. this is specially true if your skin is wet or if probes or wires penetrate your skin. Your body is protected by the high resistance of dry skin, but if this protection is bypassed then lethal currents may flow through your body on contact with a low voltage supply. Make sure your skin is dry and avoid skin punctures with probes or component leads.
13. Most instruments are provided with a grounded plug for use inj a three-hole grounded socket. The ground provides protection in case a fault occurs in the instrument or lethal voltage is otherwise applied to the instrument case. DO NOT DEFEAT THIS PROTECTION by improperly using an adapter to bypass the safety ground (for example, by pluggin into a two-hole socket).

1.3 Standard equipment and components

Certain standard equipment will be available at each bench during the experiment. This includes:

1. Function generator.
2. Digital multimeter (input bandwidth 3Hz to 300kHz).
3. Power supplies.
4. Analog oscilloscope.

Additional equipment may also be available, as required by a particular experiment, and a manual will be on hand for each test instrument that warrants one. Probes and test leads will be available as necesary.

One Hewlett-Packard LCR meter or an equivalent will be available in the lab for component value measurement as required. you will find that the actual value of commercial components often varies significantly from the nominal (advertised) value. you should usually measure all of the components that you use during an experiment, and check for non-ideal characteristics (resistance in inductors, leakage and equivalent series resistance (ESR)in capacitors, etc.)

1.4 Lab report requirements

you are responsible for deciding what is important to include in each report, and what the format of the report should be. Each time you complete an experiment and the results have been checked by the teacher, you can work on your report and must turn it in before the next lab session.

Formal reports are detailed accounts of what you have done in preparation for an experiment, what your goals are in performing the experiment, and the results you achieved. You should think of this as an Engineering report that you might produce while working on a project for your employer. You are trying to completely define the problem, set up the procedure, provide background material, and explain your laboratory results in a professional manner.

Informal reports are shorter, less detailed reports in which you report your experience in the lab and explain your results, but are not asked to package the report with complete details of experimantal procedure and measurements techniques.

You are expected to use the theoretical background that you have learned in your other classes to explain the results that you obtain, regardless of the type of report. How well you do this will determine the largest part of your grade in this laboratory course.

Formal Reports: A complete formal report shoul be written according to the following lab report format:

1. COVER: Put the following information on the cover page:
   (a) Course number.
   (b) Topic of the experiment.
   (c) Your name and your partners' names.
   (d) The dates of both experiment and report.

2. ABSTRACT: Brief introduction to the experiment. An abstract should be no more than 100 words in length and should summarize th ersults of the experiment, not the procedure.
3. DESCRIPTION OF CIRCUIT: A brief introduction of the circuit you designed or built, the components used, and drawings of th ecircuits diagrams.
4. DESCRIPTION OF MEASUREMENTS: State explicitly what physical quantities you were interested in, and how you measured them. Include brief discussions on special techniques, or references to your text (chapter, page), and how you implemented all measurements. Pay particular attention to the effects any instrument might have on your circuit; circuit loading, frequency response of the instrument, etc. *All of your pre-lab work should be contained in this portion of the report, plus extra information that you feel is necesary for any competent engineer to reproduce your measurements.*
5. RECORDS: put your measured DATA and theoretical DATA in tabular form so they can be compared easily. Graphs should be used anywhere that they can clarify your data. Graphical data representation is one of the most powerful tools that engineers have to communicate ideas. Use graphs liberally, and make sure that all axes, data points, and curves are labeled appropriately.
6. ANALYSIS: Compare your results with theoretical predictions and discuss errors, any unusual phenomena, etc. observed during the experiment. Lengthy calculations should be included in an appendix. write this portion of your report remembering that your TA will use your analysis to evaluate your understanding of the concepts that are presented in each experiment.
7. QUESTIONS: Each experiment handout will have several explicit questions, located anywhere in the handout, that must be answered in this section of the report. *Make sure you identify what question you are answering!.*

Informal reports: An informal report should contain the same material as a formal report except section 4 (Description of Measurements). Section 5 may be abbreviated. In fact, section 5 can be simply a copy of your lab notebook, if you think that the information in your notebook could be easily read and understood by your instructor (but note, your instructor will be the judge of neatness).

1.5 Preparation for the lab.

You will receive a description of each experiment approximately one week before the experiment is to be performed. The description will contain an introductory discussion and one or more circuits to be examined during the experiment. Most experiments will require that you perform some calculations and do some research before coming to the lab. Each student is expected to beprepared for each experiment. Your lab notebook should contain any preparatory notes and calculations, and you must turn in a copy of your preparatory work before you perform an experiment. If you fail to do the preparatory work, you will not be allowed to perform the experiment (and inadequate preparation, as judged by your instructor, may result in partial or total loss of credit for an experiment).

2 The experiments

With the preliminaries out of the way, you are ready to begin the experiments. Remember:

1. Read each week's experiment **before** coming to lab. Try to understand the objectives of the experiment and determine what information you should gather (in your laboratory notebook, of course).

2. Note the questions that are asked within the experiment description, especially those that are **bold-faced**. Make sure you understand these questions and know how to get the information to answer them.

3. Do any pre-lab calculations and be prepared to show these to your instructor.

4. ***Make sure you bring your notebook with you to the lab!***. You can't do the experiment without it.