ROCHESTER INSTITUTE OF TECHNOLOGY
MICROELECTRONIC ENGINEERING

# EEEE 482 Electronics II Laboratory

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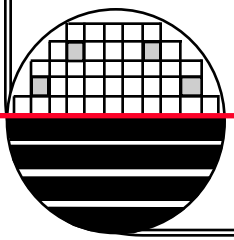

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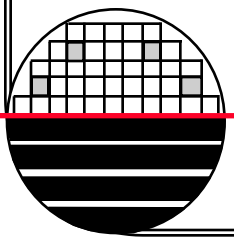


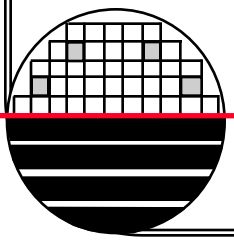
# *INTRODUCTION*

This course will provide a continuation of electronic circuit design that was the topic of EEEE 481 Electronics I.

About half of the course will cover traditional topics on bipolar analog integrated circuits. The second half will cover topics in digital electronics.

This course will enhance the students understanding of how SPICE parameters are linked to the manufacturing process and how to extract these parameters so they can be used by circuit designers.

This course will teach the student how to trouble shoot complex circuits, an important skill for engineers.



# *INSTRUCTOR INFORMATION*

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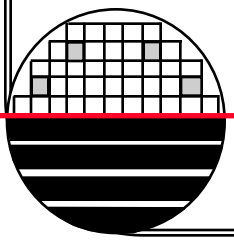


# EEEE 482 LABORATORY DETAILS

**EEEE 482 Electronics II Laboratory**

**Prerequisites:** EEEE 360 (Device Physics) or Equivalent
and EEEE 481 (Electronics I)

**Course Goals:** This is the second course in a two course sequence in electronic circuit design. The course will cover BJT and MOS analog and digital electronic circuit design.

**Format:** The lecture meets three times per week and the lab meets one time per week.

**Laboratory:**

| | |
|---|---|
| 8:00am to 10:50am Monday | GLE-3200 |
| 2:00pm to 4:50pm Monday | GLE-3280 |
| 11:00pm to 2:00pm Wednesday | GLE-3280 |

**Laboratory Grade:**

| | |
|---|---|
| Pre-lab | 10% |
| Simulations | 10% |
| Lab Performance | 10% |
| Each Tech Memo | 10% |

# ACCESS LAB DOCUMENTS FROM DR. FULLERS WEBPAGE

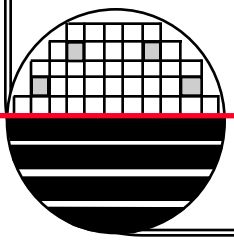
**Rochester Institute of Technology** **Revised: August 14, 2014**
**Electrical and Microelectronic Engineering**
**Dr. Lynn Fuller**

## EEEE 482 Electronics II Laboratory

| Week No. | Topic | Document | References | Assignment |
|---|---|---|---|---|
| 1. | Introduction, Schedule, Policies, Tech Memo Template | EEEE 482 Lab Outline.pdf<br>Tech Memo Instructions.doc | | Read These Documents |
| 2. | SPICE Review<br>LT SPICE is very similar to OrCAD PSPICE. It is free, has no limits on number of components and easy to use. Ideal for your personal computer. | OrCAD PSPICE Intro<br>OrCAD PSPICE Intro.pdf<br>OrCAD PSPICE Models.txt | Intro to LTSPICE<br>LTSPICE Models.txt<br>Intro to LTSPICE.wmv | Review LTSPICE<br>Do SPICE Intro Examples |
| 3. | Semiconductor Device Characteristics and Parametric Testing | BJT Characterization.pdf | | Do BJT Characterization HW |
| 4. | Common Emitter Amplifier Design | BJT Amplifiers.pdf<br>EEEE 482 Lab0 Rev2 1.pdf | | No Report |
| 5. | Differential Amplifier with Resistive Load and Current Source Bias | EEEE 482 Lab1 Rev2 3.doc | | Tech Memo Due Next Week |
| 6. | Multistage Amplifier Design | EEEE 482 Lab2 Rev2 0.doc | | Tech Memo Due Next Week |
| 7. | Global Feedback in BJT Multistage Amplifier | EEEE 482 Lab3 Rev1 3.doc | | Tech Memo Due Next Week |
| 8. | This week will be used to get caught up ... finish up all the BJT labs. | | | |
| 9. | Review of SPICE MOSFET Models<br><br>Work on your Prelab for NMOS Inverters (Long Prelab) | Intro SPICE MOSFET Models | Intro SPICE MOSFET Models<br>SPICE MOSFET Models<br>RIT_Models_For_LTSPICE.txt | Review these documents |
| 10. | Design, Simulation and Testing of NMOS Inverters | EEEE 482 Lab4 Rev2 6.doc | | Tech Memo Due Next Week |
| 11. | CMOS Inverter and CMOS Combinatorial Logic | EEEE 482 Lab5 Rev2 7.doc | | Tech Memo Due Next Week |
| 12. | CMOS Sequential Logic | EEEE 482 Lab6 Rev2 5.doc | | Tech Memo Due Next Week |
| 13. | Propagation Delay Through CMOS Logic | EEEE 482 Lab7 Rev2 4.doc | | Tech Memo Due Next Week |
| 14. | MOS Based Memory | EEEE 482 Lab8 Rev2 3.doc | | Tech Memo Due Next Week |
| 15. | No Lab | | | |

# *ATTENDANCE*

Attendance is mandatory. If you have a valid reason for missing lab, inform your TA/Instructor **before** the day of the lab. Laboratories will be made up by appointment only. Possibly during one of the other lab meeting times or when no lab is scheduled. **It is your responsibility to inform the TA/Instructor in advance and to schedule a time slot during which to make up the experiment.**

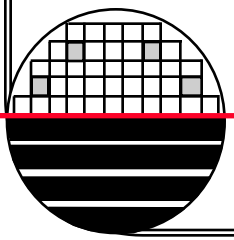


# *LABORATORY REPORTS*

Use the Tech Memo Format. Submit the Tech Memo via MyCourses. The reports are due one week after the lab work is completed late reports will be graded but may have the grade lowered.

Grading: Each Lab is 40 points

| | |
|---|---|
| Pre-Lab Hand Calculations | 10 points |
| Pre-Lab SPICE | 10 points |
| Build and Data Collection | 10 points |
| Tech Memo | |
| Abstract | 3 points |
| Theory or Design | 2 points |
| Results | 2 points |
| Discussion | 3 points |

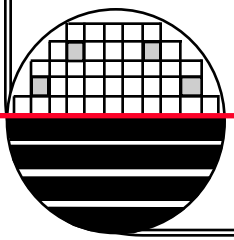


# *LATE POLICY*

Reports are generally due at the beginning of class when the lab next meets. For example, if your lab is on Monday, your lab report is due at the **beginning** of lab on the next Monday that the lab meets.

**Late points for reports will be assessed at the rate of 10 points per day**. The maximum late penalty for a given report is 50%. The maximum grade for labs handed in after five days is 50%.

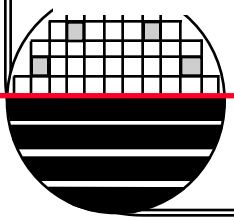
**No reports will be accepted after 5 PM on Friday the last day of classes.**



# *PRE LAB*

**The pre-lab for each experiment MUST be completed BEFORE coming to the lab.** If you do not understand a part of the pre-lab, then it is your responsibility to get help before the lab. Pre-lab theoretical calculations must be done **individually** and be presented neatly at the beginning of lab on a separate sheet of paper. The pre-lab helps you understand how to perform the lab, what is being done, and how to interpret your results. It is to your benefit to have the pre-lab done in advance. You will be **penalized if your pre-lab is not completed** when the TA/Instructor comes around to check it off.

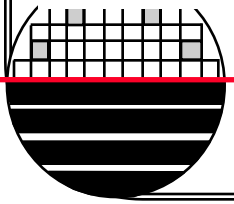
Simulations must be presented electronically in a Word document or PowerPoint, which needs to be open and ready at the beginning of lab. **PLEASE DO NOT PRINT THEM OUT**. Theoretical calculations must be presented neatly on a separate sheet of paper at the beginning of lab and included in the Tech Memo as an appendix.



# *SIMULATIONS*

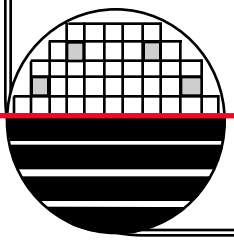
Simulation is expected to be performed on OrCAD Capture CIS. Students may use the PCs in the CEDA lab or any of the other labs they may have access to. Capture CIS is installed on all PCs on the EE (3rd) floor. You can obtain an Orcad Lite Demo CD for free by visiting http://www.orcad.com/ and clicking on the download link. The Demo CD will be mailed to you after filling out the user profile. You can also download the student version from the website as well. It's a zipped file that is about 28MB in size.

It should be noted that simulation is meant to be used for confirmation of hand design before the construction of the circuit in the laboratory. It is poor engineering practice to use the simulation for designing circuits by a trial-and-error method, as this reinforces a lack of understanding of the circuit design process.



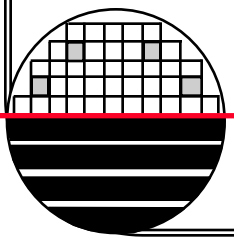
# *WORKING IN GROUPS*

The pre-lab and simulation portions of each experiment should be done individually. Students can work in groups of up to two people for the hardware portion of each experiment. At the time of hardware check-off, both students in the group must be present and present their circuit for verification. **Each student must turn in his/her own, original report. Reports are not to be completed in groups.**



# *LABORATORY SUPPLIES*

Prototype board
Breadboard supplies – wires, pliers, wire stripper
Scope Probes
Tape, scissors



# *RECOMMENDATIONS*

Pre-Lab

Hand calculations can be included as an appendix in the lab report. (as a scan or picture)

SPICE Simulations:

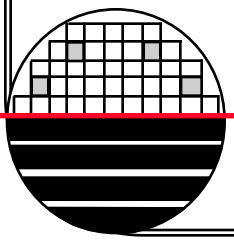
Schematic should show DC voltages, transistor L and W.

The transistor model used for the simulation needs to be justified and described in the report.

Plots should have white background, the graph lines should be thick, text should be big enough to read.

Hardware Build:

Oscilloscope data should be collected with two scope probes.



# *RECOMMENDATIONS*

Abstract

The abstract should be 3 or 4 sentences that describe the work and give the most important results. If someone reads the abstract they should not need to read the rest of the lab unless more detail is desired.

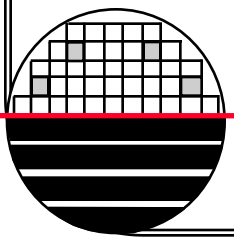
Theory and Design

Theory, Calculations, SPICE

Results

All the data collected in lab.

Discussion



# TEXTBOOK/REFERENCES

You may wish to use the following textbooks as references. Lab documents are will be provided on Dr. Fuller's webpage.

1. Microelectronic Circuits, Fifth (or Sixth) Edition, Adel Sedra and Kenneth Smith, Oxford University Press, 2001.

2. Any Device Physics textbook.

3. PSPICE Users Guide.