EE236 Course outline

17 July 2018

Electronic Devices Lab – EE 236
(http://wel.ee.iitb.ac.in/teaching_labs/WEL%20Site/ee236/ee236.html)

Course Instructors:

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Introduction

- Welcome to Wadhwani Electronics Lab (WEL), your home for all things electronics for the next few years
- EE 236 is your first formal lab course in WEL, and a good opportunity to master all the tools and get to know WEL members and become part of the eco-system
- "In theory, theory and practice are the same. In practice, they are not."
- These labs are very different from your 1st year PH and CH labs. Leave aside all expectations formed based on those lab courses.
- **Your transition from entrance exam toppers to engineers begins with this lab course**

LEARNING OBJECTIVES

After completing EE 236 course you will be able to :

- **Lab skills**: Master the use of lab equipment such as DSO, function generator, multi-meter, and power supply
- **Device characterization**: Conduct basic electrical measurements of electronic devices such as PN junction diodes, Zener diodes, LEDs, solar cells, MOSFETs, etc.
- **Applying concepts**: Analyze measured data and obtain device performance parameters (carrier lifetime in photodiode, solar cell fill factor etc.); creative thinking
- **Simulations**: Use ngspice for circuit simulation and device characterization
- **Data representation**: Use plotting software such as Gnuplot/Origin, technical writing skills (Latex)

Logistics

- The class is divided in two batches:

  Batch A (Dual Deg.) on Mondays 2 pm to 5 pm

  Batch B (B. Tech.) on Tuesdays 2 pm to 5 pm

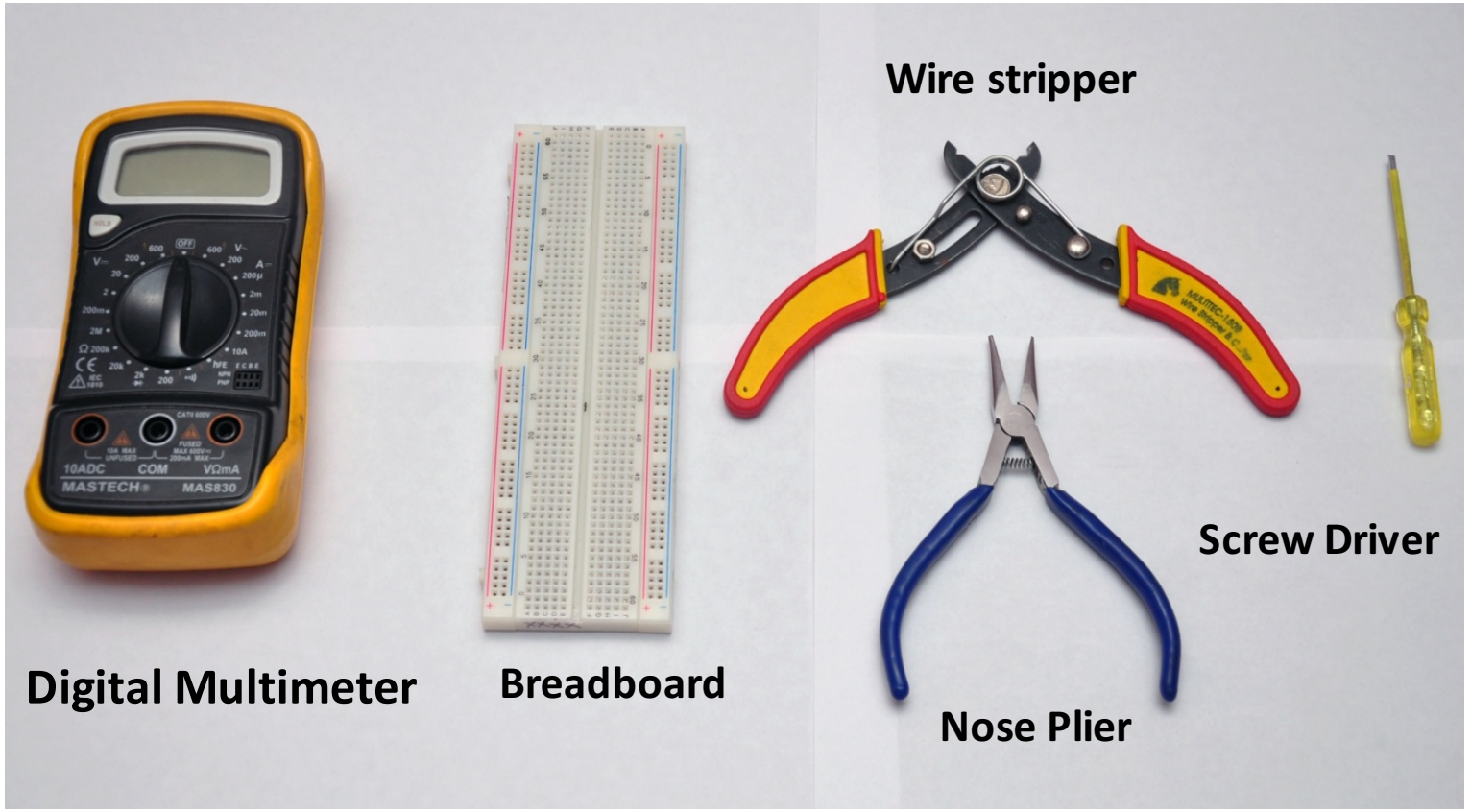
- You will be working in pairs. Pairs, seating arrangement and TA allotment will be posted on moodle and course webpage.

- Venue: Wadhwani Electronics Lab-4 (WEL-4)

- Reading work will be assigned every lab. You are expected to come prepared for every lab. Wherever necessary, we will include a 15-20 minutes lecture at the start of a lab to teach relevant device theory

TOOLS REQUIRED

Every student is expected to buy a set of tools shown below by **July 30th**. These will serve you well in all your future WEL Lab courses. List of **recommended vendors** will be made available on moodle.



BEFORE YOUR LAB SLOT

- Pre-lab reading and post-lab work (simulations, questions, report) will be assigned for each experiment.

- **You MUST have dual boot (Ubuntu-16.04 LTS and Windows-7 or above) laptops. OS must be installed and tested before the first lab.**

- **We will conduct quizzes to test pre-lab preparedness. Quiz marks will be counted as in-session credit.**

DURING YOUR LAB SLOT

- **You will not be allowed to enter the lab without your tools and notebook and will be marked absent.**
- **No penalty for making mistakes during lab. Learn from your mistakes. Document your mistakes honestly in your reports.**
- WEL is shared by multiple courses. You must finish your work in your allotted slot. Extension requests will not be entertained.
- You will run short of time if you come unprepared. If you feel you will need more time, you may start at 1:45pm instead of 2pm
- Before you leave the lab, you must upload your experimental data to Moodle (MS Excel/Libreoffice allowed). We will check your reports against your submitted data for academic integrity.

LAB DISCIPLINE – AFTER YOUR LAB SLOT

- Post lab work will be due on THURS night for both batches.
- Reports **must** be written in Latex, plots **must** be drawn in GNUplot or any other professional plotting software, circuit diagrams **must** be drawn with Xcircuit. Documents written in MS Word/Excel plots/Libreoffice will be rejected outright, and 0 marks will be awarded for corresponding post-lab.
- We will use Turnitin and heavily penalize those found guilty of plagiarism (both supplier and recipient). *Ask your 3rd year seniors if you don't believe me!*
- **Emphasis will be on writing style and content. If your experiment does not work, debug and write down your observations and hypotheses.**
- **The goal is not to finish the experiment blindly, but to learn from the experience. *No marks will be deducted* if your experiment doesn't work as expected, as long as you clearly reason out what you tried and where you might have gone wrong.**

Documentation

- You must maintain an **individual** lab notebook for your in-session work, pre-lab work, post-lab analysis etc. (48 pages A-4 size book should suffice)
- You must get it checked (signed and dated) by your TA as soon as you enter the lab (for pre-lab work) and at the end of the lab for your in-session work. The instructors will periodically do random notebook inspections.
- Before you sign and date your notebook, you must have uploaded your readings and plots. Upload your in-session and post lab work on moodle page for EE236. The upload link will be created every week with appropriate deadlines.
- Although group mates work together, report should be written individually (both group mates lose credit if reports are identical)
- **No credit for late submissions (even a few seconds late is technically, late). Start working on your reports well in advance of deadline. Respect deadlines.**

LAB DISCIPLINE

- Attendance is **mandatory.**
- Failure to carry your lab kit and tools and notebook = absent. No excuses entertained.
- If you can not attend a lab session, inform stakeholders **at least 1 day in advance (email)**
  - Stakeholders are your instructors, TA and lab staff
  - Intimation of absence in advance is not equivalent to approval
- If your absence is approved, complete your work including uploading of the postlab work before the next lab turn
  - Failure to do so will disqualify your credits for the lab you missed
  - It is your responsibility to coordinate with your TA and lab staff for mutually convenient slot. You must keep the instructors in the loop on all communication.

GRADING POLICY (TENTATIVE)

In session marks	30%

(Each experiment carries 20 points with – 10 pts. for quiz, 10 pts. for postlab)

Mid semester: simulation	15%
Mid semester: experiment	15%
End semester Exam	40%

***NEW**

Core: Mandatory work-load (pre-lab reading, in-lab and post-lab) is expected to require roughly 5-6 hours of effort. This *qualifies* you for a maximum grade of 'AB'.

Advanced: Some labs will carry an advanced component that will require additional effort. These components will not carry additional marks, but satisfactory performance in all advanced components *qualifies* you for a maximum grade of 'AA'.

List of experiments (tentative)

*New experiments

1 Familiarization with hardware and software

2. Introductory RC circuits and applications: rectifiers, filters, ngspice exercise

3. Hall effect: applications in sensing

4. Heart rate monitor: applications of filters, amplifiers and diodes

5. Measuring diodes: estimate material band gap, measuring speed

6. Effect of temperature on p-n junction parameters (solar cell): first foray into experiment automation

7. Transient measurements of diode: minority carrier lifetime measurement

8. Extraction of device parameters from capacitance measurement: MOSCAPs and solar cells (devices fabricated at IITB)

9. Experience the versatility of MOSFETs

10. MOSFET application: inverter (NOT gate)

11. Advanced MOSFET application: ring oscillator, measuring delay

12. JFET application: microphone

Up to 6 students will be selected and given hands-on training for fabricating solar cells from silicon wafers (selection criteria TBD; will be tied to performance in this course)

To-do List before next lab

- Watch video on instrument familiarization, xcircuit and gnuplot tutorials
- Practice using xcircuit and gnuplot
- Install xcircuit, Latex and gnuplot on your Ubuntu machines. Dual boot your machine if you also want to keep Windows. (Mac users may use lab desktops)

How does an experimentalist think?

- **Aim:**
  - What do we seek to measure?
- **Apparatus:**
  - What devices, instruments do I need?
- **Experiment:**
  - What measurements must I conduct?
  - What is the right way to obtain these measurements?
  - What is the accuracy of my measurement? What errors are present in my experimental data?
- **Observations/Data interpretation:**
  - What do my data tell me? Is it what I expected?
  - How must I visualize my data to obtain insights/information
- **Conclusions**
  - Based on my experiment, what inferences can I draw?
  - How can I improve my experiment in future? What breakthroughs are needed?

How does an experimentalist think? – EXAMPLE

- Aim:
  - What do we seek to measure? – minority carrier lifetime in a photo-diode
- Apparatus:
  - What devices, instruments do I need? – photo-diode, light source, some way to switch the light source
- Experiment:
  - What measurements must I conduct? – many right answers, think: efficiency!
  - What is the right way to obtain these measurements? – discover in lab
  - What is the accuracy of my measurement? What errors are present in my experimental data? – too advanced for this course; some discussion in labs
- Observations/Data interpretation:
  - What do my data tell me? Is it what I expected – usually a lot of information! Simulations are your friends
  - How must I visualize my data to obtain insights/information? – many right answers, think sharing!
- Conclusions
  - Based on my experiment, what inferences can I draw?
  - How can I improve my experiment in future? What breakthroughs are needed?