



ELEC3106

Electronics

COURSE INTRODUCTION — session 1, 2009

Course Staff

Course convener: Dr. T. Lehmann, room EE208, tlehmann@unsw.edu.au
 Laboratory demonstrators: Hamid Teimoori, Kuan Yen Tan, Graeme Lowe, Yiwei Xu,
 Hosung Chun, and Jack Danger

Consultations: Students are encouraged to use the open consultation hour rather than contact by email; students may seek consultation with the course convener at other times by appointment.

Consultations: Mondays, 4pm–5pm, room EE231A or EE208

Course details

Credits: The course is a 6 UoC course; expected workload is 10–12 hours per week throughout the 12 week session.

Contact hours: The course consist of 3 hours of lectures per week, 1 hour of tutorials per fortnight, and 2 hours of laboratory sessions per week:

Lectures:	Tuesdays,	2pm–5pm,	theatre EE-G25
Tute sessions:	Mondays,	5am–6pm,	room Quad-G031 (odd weeks)
	Tuesdays,	5am–6pm,	room Quad-G035
Lab sessions:	Tuesdays,	9am–11am,	room EE-101
		11am–1pm,	room EE-101
	Wednesdays,	9am–11pm,	room EE-101
		11am–1pm,	room EE-101
		1pm–3pm,	room EE-101
	Thursdays,	4pm–6pm,	room EE-113
		9am–11am,	room EE-101
Fridays,	9am–11am,	room EE-101	
	11am–1pm,	room EE-101	

Tutorial classes and laboratory classes start in week 2.

Course Information

Context and aims

Physical electronic circuits and systems are plagued by a number of undesired effects that the designer need be aware of in order to implement electronic circuits that operate as intended under the influence of the effects. Electrical noise and non-linearity, for instance, limit the dynamic range in analogue circuits; dynamic power supply current demands can cause power supply voltage drops leading to corruption of digital data; electromagnetic interference (EMI) can cause system malfunction; parasitic components (e.g. stray capacitances) limit the operating frequencies of all circuits. Modern state-of-the-art electronic systems, such as laptops and mobile phones, are actually extraordinarily difficult to implement, and the designers must have a thorough knowledge about the non-ideal behaviours of the technology. The *Electronics* course introduce the student to a number of important undesired effects of electronic systems and ways to deal with these; also, it introduces some more advanced circuit functions.

Aims: The course aims to make the student familiar with critical non-ideal effects in electronic devices and systems, thus enabling the student to design and construct physical electronic circuits that operate as desired.

Relation to other courses

The course is a new third year core course for students following the BEE program at the University of New South Wales, and is offered as an elective for other students. The course completes the core electronics subjects offered in the school and serves as pre-requisite for more advanced courses in electronics design. The course should be taken by students that plan to design physical electronic systems, such as done in the following ELEC3117, Electrical Engineering Design course.

Pre-requisites: The pre-requisites for the course are ELEC2133, Analogue Electronics, and ELEC2141, Digital Circuit Design. ELEC2133 may be taken as a co-requisite. It is also required that the students have good working knowledge of circuit theory and some basic signal analysis as covered in the courses ELEC1111, Electrical and Telecommunications Engineering, and ELEC2132 Circuits and Signals.

Assumed knowledge: It is further assumed that the students are familiar with SPICE-like circuit simulators, and are able to operate electronics laboratory equipment independently.

Following courses: The course is a pre-requisite for the fourth-year professional elective courses in the electronics area: ELEC4601, Digital and Embedded Systems Design, ELEC4602, Microelectronics Design and Technology, and ELEC4604, RF Electronics. These courses are again pre-requisites for post-graduate level courses in electronics.

Learning outcomes

After the successful completion of the course, the student will be able to

1. appreciate critical non-ideal effects in analogue and digital electronic circuits,
2. appreciate the wealth of electronic circuit functions available,
3. appropriately design for EMC,
4. design simple power supplies and circuits,
5. interface analogue circuits and digital circuits,
6. appreciate the need for robust firmware, and
7. design electronic circuits that work reliably.

The course delivery methods and course content address a number of core UNSW *graduate attributes*; these include:

1. The capacity for analytical and critical thinking and for creative problem-solving, which is addressed by the laboratory and tutorial exercises.
2. The ability to engage in independent and reflective learning, which is addressed by the laboratory design task.
3. Information literacy, which is addressed by the homework.
4. The skills of effective communication, which are addressed by the reports.

Please refer to <http://www.ltu.unsw.edu.au/content/userDocs/GradAttrEng.pdf> for more information about graduate attributes.

Teaching strategies

The course consists of the following elements: lectures, laboratory work, home work, and tutorials:

Lectures

During the lectures technology capabilities and design issues are discussed and theoretical aspects of electronics design and technology are presented. The lectures provide the students with a focus on the core material in the course, and a qualitative, alternative explanations. Numerous examples of analogue and digital electronic circuit functions are discussed in order to convey a qualitative understanding of circuit operations, non-idealities, and EMI. The lectures aim to support students in identifying and analysing non-ideal effects in circuits, to aid the student in how to mitigate such effects, and finally to help the students appreciate the capabilities and limitations of the technology. Students are expected to attend the lectures and prepare themselves for them.

Laboratory work

The laboratory work provides the student with hands-on experience in measuring non-ideal effects and EMI in electronic circuits, and thus helps to re-enforce the central topics in the course. Most of the laboratory work being carried out on bread boards constructed by the students, also

exercises the students ability to set up measurements and locating circuit errors. The final laboratory exercise is a small design task which aims to draw together theoretical and practical design aspects in a small open-ended design problem. Students design a circuit meeting given specifications prior to the final laboratory session and characterise the circuit during the laboratory session. The design task provide and test engineering creativity, open-ended problem solving skills, communication skills and general understanding of the course content. Students must come prepared for all laboratory sessions; the laboratory sessions are short, so this is only possible way to complete the given tasks.

Home work

The lectures can only cover the course material to a certain depth; students must read the textbooks and reflect on their content as preparation for the lectures to fully appreciate the course material. Home preparation for laboratory exercises provides the student with quantitative understanding of electronic circuit non-idealities. The home work aim to provide in-depth quantitative and qualitative understanding of analogue and digital electronic circuits. Note that no lecture notes will be handed out for most parts of the course. The ability to read the recommended text book and identify critical parts with the aid of the lectures is regarded as an essential component of this course.

Tutorials

The tutorials provides the student with in-depth quantitative understanding of circuit analysis and non-ideal circuit properties. The tutorials take the student through critical course topics and aim to exercise the students circuit analysis skills.

Assessment

There are four components of the assessment in this course:

Laboratory work: 15% overall weight
Quizzes: 10% overall weight
Final examination: 75% overall weight

Assessment task due dates are given in the course schedule.

Laboratory work: The laboratory work is assessed in order to ensure that the students understand the material in this essential course component; thus, this assessment test that the student can use the lab equipment, understand circuit models and non-idealities, carry out measurements, and can design simple circuits. Laboratory work must be documented in brief reports which are due one week after the laboratory session at 5pm. Late submissions carry a 50% penalty for the first week and will not be accepted beyond one week delay. Delays on medical grounds are accepted. The reports should be dropped into the school assignment box next to room G12A. Assessment is grade-only marks based on lab work and reports (a HD mark is given only for exceptional performance; a serious attempt at completing the problems is required for a PS mark)

Quizzes: There are two quizzes held during the lecture time through the semester. which are provided in order to give early feed-back on student performance. The quizzes test the students

general understanding of the course material; assessment is a graded mark according the correct fraction of the answers to the quiz questions.

Final examination: The exam in this course is a standard closed-book 3 hours written examination; University approved calculators are allowed. The examination test analytical and critical thinking and general understanding of the course material in a controlled fashion. Assessment is a graded mark according the correct fraction of the answers to the exam questions.

Course contents

Handbook entry: Non-ideal effects in electronic circuits and systems: Noise; device noise, external noise, CMRR, PSRR, mixed A/D. Distortion; non-linearity, dynamic range, saturation. Stability and performance sensitivity to parameter variations. Some simple design for stability and performance. Design optimisation. Power-supply distribution and decoupling. Mixed analogue/digital system design, including grounding and shielding. Device modelling in SPICE. Data sheet interpretation. Design of analogue and digital circuits and system components: Non-linear circuits; oscillators, PLLs, multipliers, AGCs, Schmitt triggers. Introduction to filter design; active filters; op-amp. Sensors and actuators, PTAT; instrumentation amplifiers and signal conditioning. Low-level design and optimisation of digital CMOS gates. Gate delay, power dissipation, noise margins, fan-out. Introduction to integrated circuit design. Thermal consideration, power supplies, reliability, μC watchdogs

Course Schedule

1:	Topic: CMRR, PSRR, CMR, offset, slew-rate, bias currents. Text: TW ch. 5; datasheets. Tasks: None.
2:	Topic: Electrical noise, distortion, saturation, dynamic range. Text: Notes; datasheets; (HH ch. 7). Tasks: Lab 1 (even), measurements on op-amp.
3:	Topic: Digital fan-out, noise margins, VTC, i/o characteristics, gate delays. Text: SS ch. 10; TW ch. 6; datasheets. Tasks: Lab 1 (odd).
4:	Topic: Interfacing to logic, opto-coupling, ESD, driving transmission lines, CMOS gate design, introduction to IC design. Text: SS ch. 10; TW ch. 6, 9; SS app. A1 Tasks: Lab 2 (even), measurements on digital gate.
5:	Topic: Grounding, external noise, decoupling, shielding, EMC, mixed A/D. Text: TW ch. 1, TW ch. 8. Tasks: Lab 2 (odd). QUIZ 1
6:	Topic: Power supplies, start-up. Text: TW ch. 7; (HH ch. 6). Tasks: Lab 3 (even), measurements of supply noise.
7:	Topic: SPICE simulations and modelling. Text: SS throughout. Tasks: Lab 3 (odd).
8:	Topic: Power stages, thermal considerations. Text: SS ch. 14; TW ch. 9. Tasks: Lab 4 (even), SPICE simulations.
9:	Topic: Active filters, sensitivity. Text: SS ch. 12. Tasks: Lab 4 (odd). QUIZ 2
10:	Topic: Guest lecture Text: None. Tasks: Lab 5 (even), active filter design.
11:	Topic: Oscillators, multipliers, Schmitt triggers, PLLs, AGCs, sensors, interfaces. Text: SS ch. 13; (HH ch. 9); (HH ch. 3); SS ch. 2. Tasks: Lab 5 (odd).
12:	Topic: Reliability, FMEA, watchdogs, defensive programming. Text: TW ch. 9; notes; TW ch. 6. Tasks: None.

SS: Sedra & Smith; TW: T. Williams; HH: Horowitz & Hill

Resources for Students

Textbooks

Prescribed textbook

The following textbooks are prescribed for the course:

A. S. Sedra & K. C. Smith, *Microelectronic Circuits*. Oxford University Press, 5th ed., 2004.

T. Williams, *The Circuit Designer's Companion*. Elsevier, 2nd ed., 2005.

Students are strongly encouraged to purchase a copies of these books as is provides coverage of most of the topics in the syllabus. Lecture notes will not be handed out on topics the books cover in sufficient detail. Note that Sedra & Smith is also used in ELEC2133, Analogue Electronics.

Reference book

The following book is an excellent additional resource:

P. Horowitz & W. Hill, *The Art of Electronics*. Cambridge University Press, 2nd ed., 1989.

Books covering assumed knowledge

The following books cover material which is assumed knowledge for the course:

R. C. Dorf and J. A. Svoboda, *Introduction to Electric Circuits*. Wiley, 6th ed., 2004.

J. F. Wakerly, *Digital Design Principles and Practises*. Prentice-Hall, 3rd ed., 2001.

A. V. Oppenheim and A. S. Willsky, *Signals and Systems*. Prentice-Hall, 2nd ed., 1997.

On-line resources

Some additional on-line resources relevant to the course:

Resource: course website <http://subjects.ee.unsw.edu.au/elec3106>
library resources [http://info.library.unsw.edu.au/web/
services/services.html](http://info.library.unsw.edu.au/web/services/services.html)

Other Matters

Academic Honesty and Plagiarism

Plagiarism is the unacknowledged use of other peoples work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a serious offence by the University and severe penalties may apply. For more information about plagiarism, please refer to <http://www.lc.unsw.edu.au/plagiarism>

Continual Course Improvement

Students are advised that the course is under constant revision in order to improve the learning outcomes of its students. Please forward any feedback (positive or negative) on the course to the course convener or via the Course and Teaching Evaluation and Improvement Process.

Administrative Matters

On issues and procedures regarding such matters as special needs, equity and diversity, occupational health and safety, enrolment, rights, and general expectations of students, please refer to the School policies, see <http://scoff.ee.unsw.edu.au/>.