ELEC 4604

RF ELECTRONICS

COURSE INTRODUCTION – Session 1, 2009

Course Staff

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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 consists of 2 hours of lectures per week, 1 hour of tutorials per fortnight, and 3 hours of laboratory session per fortnight.

Lectures:	Tuesdays 12-14, EE222
Tutorial Sessions:	Tuesdays 14-15, EE222, Thursdays, 3pm – 4 pm, Room EE 222,
Lab Sessions:	Thursdays, 3 pm –5 pm, Room EE 125,

Tutorial classes and laboratory classes start in week 2.

Consultation: Tuesdays 15-16, EE305

Students are encouraged to use the open consultation time rather than contact by email.

COURSE INFORMATION

Context and Aims

Wireless communication is one of the fasted growing technology areas and is found in wireless systems like Global Positions Satellite (GPS) systems, Wireless Local Area Networks (WLANs), paging systems, Direct Broadcast Satellite (DBS) television, Radio Frequency Identification (RFID) systems, and mobile phones. These systems have the capability of providing global connectivity for voice, vide, and data communications. Hence, there is enormous commercial interest in this technology and never enough supply of competent RF engineers.

This course will look at the hardware aspects of wireless systems form a radio frequency perspective. The course will cover many of the RF building block in any RF communication transceiver system: basic passive and active RF components, RF device models, transmission line principles, Smith charts, generalized matrix representation of RF circuits, analysis of multiport RF networks, introduction to modern planar technologies, lumped and distributed microstrip circuits, analysis of microstrip circuits, RF resonators, RF filters, RF amplifiers, RF oscillators and mixers.

This course aims to convey to students an understanding of RF background for both the design and analysis of RF devices. Assumed knowledge of this course includes electromagnetic theory background and understanding of circuit theory techniques.

Aims

The course aims to make the student familiar with RF circuits and enable the student to analyse, design and implement RF circuits.

Relations to other courses

The course is a four year elective offered to students in a BEE course at the University of New South Wales. The course gives the foundation for RF electronics circuit design. The course should be taken by students that plan to design building blocks in communication systems.

Pre-Requisites: The pre-requisites ford the course is ELEC 2133 Analogue Electronics, ELEC 3115 Electromagnetic Engineering. It is essential that the students are familiar with circuit theory, basic analogue electronics and communication principles.

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

Following Courses: The course will provide essential basic understanding to attempt the postgraduate course ELEC 9702 RF Integrated Circuits and TELE 9355 Microwave Theory and Circuits, which are core courses in the Microsystems and Microelectronics, in the Telecommunications and in the Master of Engineering Science post-graduate specialisation coursework program, offered by the School.

Learning Outcomes

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

1. Analyse and design RF circuits
2. Use modern CAD design techniques to simulate RF circuits
3. Use modern instrumentation to measure the RF circuit parameters
4. Understanding of the limitations of conventional low frequency circuit and RF circuit analysis

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

1. The capacity for analytical and critical thinking and for creative problem-solving, which is addressed by the design task and tutorial exercises.
2. The ability to engage in independent and reflective learning, which is addressed by the 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/GradAttEng.pdf for more information about the graduate attributes.

Teaching Strategies

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

Lectures

The lectures, delivered in the class, will cover a range of RF topics. They will begin with a revision of basic RF topics like transmission line theory, Smith Charts taught in ELEC3115. Noise and linearity principles, S-parameters will be taught as they are essential performance parameters for any RF system and its constituent functional blocks. The essential building blocks of a standard RF system will be considered and analysed. There include RF components such as matching networks, resonators, RF filters, RF amplifiers, RF oscillators and RF mixers.

Laboratory work

The laboratory work provides the student with opportunity to measure and characterize the RF components and circuits using the network analyser and develop sufficient competency in utilizing equipment of this nature. Simulation experiment will expose students to the state of the art CAD software for RF design. All laboratory work must be recorded in lab Book and not in loose sheets of paper. The lab work will be marked by the demonstrator during the lab session.

The project will allow the student to use Agilent Advanced Design System (ADS) software. ADS is the industry leader in high-frequency design. It supports system and RF design engineers developing all types of RF designs, from simple to the most complex.

Home work

The lectures can only cover the course material to a certain depth; students must read the textbook and reflect on its content as preparation for the lectures to fully appreciate the course material. Students are encouraged to read the text book and reference materials. Home preparation for laboratory exercises provides the student with quantitative understanding of the experiment.

Self-guided tutorials

The self guided tutorials provide the student with in-depth quantitative understanding of RF circuit analysis. The tutorials take the student through all critical course topics and aim to exercise the students RF circuit analysis skills. The students are strongly encouraged to complete all the tutorials; the problems may be discussed in the tutorial sessions. These tutorial sessions are interspersed with the lab times. Refer to the course schedule.

Assessment

There are the following components of the assessment in this course:

Assignments:	15% overall weight
Laboratory work:	20% overall weight
Project:	15% overall weight
Final examination (open book):	50% overall weight

Assessment task due dates are given in the course schedule.

Final examination:

The exam in this course is an open 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 to the correct fraction of the answers to the exam questions.

Assignments:

There are two assignments held through the semester, which are provided in order to give early feedback on student performance and general understanding of the course material in a controlled fashion.

The assignments will allow the students to explore the subject in great depth and would consume more effort and time than the normal tutorial questions. Deadline for the submission of assignment are in the course schedule.

Laboratory Work and Project:

Laboratory work must be documented in brief reports which are due one week after the laboratory session at 5pm. However when possible (e.g. shorter lab experiments), students are encouraged to submit the reports at the end of the lab session. Reports should be dropped into the school assignment box next to room G12A. Assessment is grade only mark based on lab work and reports.

The project will allow the student to use Agilent Advanced Design System (ADS) software. ADS is the industry leader in high-frequency design. It supports system and RF design engineers developing all types of RF designs, from simple to the most complex, from RF/microwave modules to integrated MMICs for communications and aerospace/defense applications. The use of ADS for this class is an attempt to offer to our students the best exposure to current best special simulators available in RF industry and research. ADS was donated to UNSW for one year use in the ELEC 9604 subject.

Course Contents
Handbook entry:

Review of the transceiver architecture. RF basics: transmission lines, Smith Charts. Matrix representation of RF circuits. S-parameters. RF active/passive devices and parasitics. RF resonators. RF filters. RF amplifiers. RF Oscillators. RF mixers.

COURSE SCHEDULE

WEEK	TOPIC	TUT	LAB
0			
1	Introduction to RF; RF components		
2	Transmission Line Theories		
3	Representation of RF Networks		
4	Analysis of Single- and Multi-Port RF Networks		
5	Lumped and Distributed microstrip circuit, analysis of microstrip circuits		
6	RF Resonators		
7	RF Filters 1		
8	RF Filters 2		
9	RF Amplifiers 1		
10	RF Amplifiers 2		
11	Noise and Linearity		
12	Oscillators and Mixers		

Experiments

L1: Familiarisation with Vector Network Analyser Calibration. And Operation;

L2: S-parameters Measurement e.g. RF filters, attenuators, and RF amplifiers.

L3: PLL experiment.

L4: Simulation of circuit linearity (1dB compression, IIP3), (optional for extra marks)

Resources for Students

Textbooks: Prescribed textbook

The following textbook is prescribed for the course:

R. Ludwig and G. Bogdanov, RF Electronics – Theory and Applications, 2nd Ed. Prentice Hall 2008

Reference books

The following books are good additional resources for topics on RF Electronics

D. Pozar – Microwave Engineering, John Wiley, 3rd Ed. 2007.

Books covering assumed knowledge

The following books cover material wish is assumed knowledge for the course
A.S. Sedra and K.C. Smith, - Microelectronic Circuits, Oxford University Press, 4th Ed., 1998.
D. K. Cheng, Field and Wave Electromagnetics, Addison Wesley, 2nd Ed., 1992.

On-line Resources

Some additional on-line resources relevant to the course:
Resources: course website: http://subjects.ee.unsw.edu.au/elec4604
library resources: http://info.library.unsw.edu/web/services/teaching

CAD Resources

Students will use the PCs in the CAD Laboratory (room 214) for all laboratory works and project.

The CAD tools used in this course is the industry standard Cadence design suite, which runs under the Linux system on the dual boot PCs. For specific details on how to long one, see the course web page. Students can access the CAD tools after hours on the dual boot PCs in the School computer laboratory located in room EEG16.

Agilent ADS will be used for the project. ADS is extensively used by the industries for RF and MW applications and have proven to be a very valuable tool. Most graduates and post graduates can easily find a design or research job if they show competency in manipulation of simulating tools, along with their knowledge of design principles.

Other Matters

Academic Honesty and Plagiarism

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

Continual Course Improvement

Students are advised that the course in under constant revision in order to improve the learning outcomes of its students. Please forward any feedback on the course to the course convenor.

Administrative Matters

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