COURSE INTRODUCTION— Session 1, 2008

Course Staff
Course conveners: Prof. Chee Yee KWOK, room EE242; cy.kwok@unsw.edu.au
A/Prof. Rodica RAMER, room EE305; ror@unsw.edu.au

Laboratory demonstrator: Hamood Khawaja

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: Monday 4pm–5pm, room EE242 or 305

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 2 hours of lectures per week, and 2 hours of laboratory or tutorials sessions per week:

Lectures: Thursdays, 9am–11am, room EE224

Laboratory/Tutorials: Room EE125
Wednesday 12pm-2pm
Wednesdays, 3pm–5pm

[Include other ‘when and where’ information here.]
COURSE INFORMATION

Context and aims

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

This course will look at the hardware aspects of wireless systems from a radio frequency (RF) perspective. The course will cover many of the RF building blocks in any RF communication transceiver system: basic passive and active RF components, RF device models, transmission line principles, multiport networks, Smith charts, modulators and demodulators, frequency up/down converters circuits, RF amplifiers, filters, oscillators, phase locked loops, noise and linearity characteristics of these building blocks, implications on overall system performance in terms of operating range, power requirements, bandwidth, data rate and error rates. In general, these subsystems are analog in nature, even when the wireless system employ digital modulation techniques.

This course aims to impart to students an understanding in RF issues, both in design and analysis. For this 4th year course in the EE&T curriculum, it will address RF issues at a PCB level with RF devices. RF microelectronics (IC) will be covered at the PG coursework level. Assumed knowledge for this course include electromagnetic theory background and sound understanding of back circuit theory techniques.

Aims: The course aims to make the student familiar with RF circuits and enable the student to do analysis and design of circuits implemented at these frequencies.

[The aims should not be ‘to achieve the learning outcomes’ (e.g. a bullet-ed list very similar to the learning outcomes). Learning outcomes are specific and measurable (‘a means to an end’), whereas aims are the concise higher level purpose (‘the end’). ‘Relation to other courses’ is taken out as a separate subsection.]

Relation to other courses

The course is a fourth year L4 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.

Pre-requisites: The pre-requisites for the course is ELEC2133 Analog Electronics, ELEC3106 Electronics. It is essential that the students are familiar with circuit theory and basic analogue electronics as well as basic communication principles covered in TELE3113.
**Assumed knowledge:** It is further assumed that the students are familiar with SPICE-like circuit simulators, and have a good computer literacy.

**Following courses:** The course will provide essential basic understanding to attempt the postgraduate course ELEC9702 RF Integrated Circuits, which is a core course in the Microsystems and Microelectronics specialisation Master of Engineering Science post-graduate coursework program offered by the school.

**Old courses:** The course replaces previous course ELEC4503 Electronics C.

**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 tools to simulate RF circuits
3. Use modern instrumentation to measure RF circuit parameters
4. Understand the limitations of conventional circuit analysis and RF circuit analysis techniques becomes necessary.

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 design task and tutorial exercises.
2. The ability to engage in independent and reflective learning, which is addressed by the design task.
3. The skills of effective communication, which are addressed by the reports.
4. Information literacy, which is addressed by the homework.

Please refer to http://www.ltu.unsw.edu.au/content/userDocs/GradAttrEng.pdf for more information about graduate attributes. *Note, graduate attributes are supposed to link to learning outcomes; I think linking them to the learning process is a lot more appropriate for us.*

**Teaching strategies**

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

*Provide here all the teaching components, motivate each of them, and outline how they address aims and learning outcomes. Then provide any details on how that component is to be handled in this course. Components that are assessed are mentioned here; pure assessment tasks are mentioned only in the next section.*

**Lectures**

The lectures, delivered in class, will cover a range of RF topics. It will begin with a revision of basic RF topics like transmission line theory and Smith charts, already taught in TELE3115. 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 generic RF system will be considered and analysed. These include RF components: matching networks, RF LNA, mixers, VCO, PLL and RF power amplifiers.
Laboratory work
The laboratory work provides the student with the opportunity to measure and characterise the RF components and circuits using the net work analyser and develop sufficient competency in utilising 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 a Lab Book and not in loose sheets of paper. The lab work will be marked by the demonstrator during the lab session.

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 provides 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.

Assignments:
Two assignments will be set for this course. Assignments will allow the student 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.

Assessment
There are four components of the assessment in this course:
Laboratory work: 20% overall weight
Assignment: 10% overall weight
Final examination: 70% overall weight
Assessment task due dates are given in the course schedule.

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 SCHEDULE  --- ELEC4604 RF Electronics

<table>
<thead>
<tr>
<th>WEEK</th>
<th>TOPIC</th>
<th>LECTURER</th>
<th>Lab/Tut</th>
<th>Notes</th>
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<tbody>
<tr>
<td>0</td>
<td>(3/3)</td>
<td></td>
<td></td>
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<tr>
<td>1 (10/3)</td>
<td>Introduction to RF; Linearity and noise; RF components</td>
<td>RR</td>
<td>L1</td>
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<tr>
<td>2 (17/3)</td>
<td>TL theory revision; Smith chart</td>
<td>RR</td>
<td>L1</td>
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<tr>
<td></td>
<td>Break</td>
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<tr>
<td>3 (31/3)</td>
<td>S parameters</td>
<td>RR</td>
<td>T1</td>
<td></td>
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<tr>
<td>4 (7/4)</td>
<td>Matching networks</td>
<td>RR</td>
<td>L2</td>
<td></td>
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<tr>
<td>5 (14/4)</td>
<td>RF amplifier, LNA</td>
<td>CYK</td>
<td>T2</td>
<td></td>
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<tr>
<td>6 (21/4)</td>
<td>Power gain, stability; Mixers</td>
<td>CYK</td>
<td>L3</td>
<td></td>
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<tr>
<td>7 (28/4)</td>
<td>Mixers, VCO</td>
<td>CYK</td>
<td>T3</td>
<td></td>
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<tr>
<td>8 (5/5)</td>
<td>VCO, PLL</td>
<td>CYK</td>
<td>L4</td>
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<tr>
<td>9 (12/5)</td>
<td>RF filters</td>
<td>RR</td>
<td>T4</td>
<td></td>
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<tr>
<td>10 (19/5)</td>
<td>RF filters</td>
<td>RR</td>
<td>L5</td>
<td></td>
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<tr>
<td>11 (26/5)</td>
<td>PLL</td>
<td>CYK</td>
<td>L5</td>
<td></td>
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<tr>
<td>12 (2/6)</td>
<td>RF power amplifiers</td>
<td>CYK</td>
<td>T5</td>
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Experiments:

L1: Simulation of circuit linearity (1dB compression and IIP3)
L2: Familiarisation with NWA, calibration etc.
L3: NWA S-parameter characterisation filters and attenuators
L4: NWA S-parameter characterisation of RF amplifier
L5: PLL experiment
RESOURCES FOR STUDENTS

Textbooks: Prescribed textbook
The following textbook is prescribed for the course:


Reference books
The following books are good additional resources for topics on RF Electronics and Circuits:

Pozar: Microwave and RF design of Wireless Systems, Wiley 2001

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


On-line resources
Some additional on-line resources relevant to the course:
Resource: course webct http://vista.elearning.unsw.edu.au
library resources http://info.library.unsw.edu.au/web/services/teaching.html

CAD resources
Students will use the PCs in the CAD Laboratory (room 214) for all laboratory works. The CAD tools used in this course is the industry standard Cadence design suite which run under the Linux system on the dual boot PCs. For specific details on how to log on, 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.

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/.