Subject syllabus

Learning plan
Activity plan

Radio-communications

Learning plan

1. Descriptive information on the subject

- **Academic year:** 2012 – 2013
- **Subject name:** Radio-communications
- **Subject code:** 21752
- **Subject type:** elective
- **Degree:** Grau en Enginyeria Telemàtica
- **Number of credits:** 5
- **Number of ECTS:** 4
- **Total number of hours to be dedicated:** 100
- **Timing:**
  - Year: 1st year
  - Type: quarter
  - Period: 3rd quarter
- **Coordinator:** Rafael Pous
- **Teaching staff:** Rafael Pous, Raúl Parada
- **Department:** Dept. de les Tecnologies de la Informació i les Comunicacions
- **Groups:** see ESUP website
- **Teaching language:** English (classroom), Catalan, Spanish or English (labs)
- **Location:** see ESUP website
- **Schedule:** see ESUP website

2. Subject presentation

Radio-communications is a basic course on antennas and propagation, with a clear practical and hands-on orientation. The students will learn:

- Antenna parameters
- Power calculations in a radio link
- Basic antenna types (wire, patch, aperture, reflectors)
- Principles of antenna measurements

This subject does not have the intention of being a comprehensive course on antennas and propagation. Several important topics are left out (radiation integrals, numerical methods, etc.), but the fundamental principles will be covered, and the student will gain a basic understanding of the main topics relevant to antenna characterization, design and measurements. This basic understanding will be enough for those students interested in the subject to use some of the very good textbooks available to dig deeper in his or her particular areas of interest.

3. Prerequisites of the subject

A good command of high-school level mathematics and physics is required. In particular, the following concepts must have been mastered before this course:

- Complex numbers

- Functions and their graphical representation
- Cartesian, cylindrical and spherical coordinate systems
- Basic differentiation and integration of functions in 1 and 2 variables
- Waves, propagation, and reflection
- Phasor notation
- Basic electromagnetic theory

In particular, the student must have assimilated the 1st year required course on Waves and Electromagnetism.

4. Evaluation

There will be a single evaluation itinerary for this subject based on:

- Laboratory (50%): there will be three lab assignments. The lab assignments will be done in groups of two students, and there will be a single qualification for both group members (only in exceptional circumstances will this principle be changed). Each lab assignment may consist of one or more deliverables (e. g. pre-lab, and post-lab). All assignments will be turned in in PDF format and through the Aula Global e-learning platform. No assignments will be accepted in other formats, through other channels, or delivered after the deadline (as enforced by the Aula Global). An assignment not delivered, delivered not according to the above requirements, or delivered late, will be graded with a 0/10. Attendance to the laboratory sessions is a strict requirement. More than two unjustified missed laboratory sessions will be a cause for a 0/10 laboratory grade. A minimum average laboratory grade of 4/10 is required to pass the course. A laboratory grade lower than 4/10 will mean that the student will have to take the class all over again, since laboratories cannot be passed in the July examination.
- Mid-term exam (20%): a mid-term exam, covering the topics taught in the classroom and laboratory sessions will be scheduled towards the middle of the subject.
- Final exam (20%): a final exam, covering the topics taught in the classroom and laboratory sessions will be scheduled during the official exam period of the University. The final exam will cover all the topics of the subject, including all those covered in the mid-term exam. A minimum average grade between midterm and final of 4/10 is required to pass the course. A grade lower than 4/10 will mean that the student will have to take the July exam (given that the laboratory grade is 4/10 or higher). In this case, the July exam will have a weight of 40% (the combined weight of the mid-term and final exams).
- Class participation (10%): a grade given by the course teachers, evaluating the degree of participation and involvement of the student in the the classroom and laboratory sessions. Asking questions, answering the questions posed by the teachers, attending the conferences by invited speakers, and a general positive attitude will all count towards this evaluation criteria. No minimum grade is required for class participation.

5. Contents

5.1. Content blocks

The subject is organized around 6 content blocks, each content block being discussed in one 2-hour classroom session:

- **Content block 1. - Antenna parameters. Antenna radiation pattern.**

    - Antenna input impedance
    - Antenna bandwidth
    - Antenna radiation efficiency
    - Antenna directivity, effective aperture, and gain
    - Antenna radiation pattern, beam-width, F/B ratio, and side-lobe level
    - Antenna polarization
- **Content block 2. - Link power calculations. Antenna temperature and SNR.**
    - Antenna as a transmitter, as a receiver, and reciprocity
    - Link power calculations and the Friis transmission equation
    - Antenna temperature and noise calculations
    - SNR calculation
- **Content block 3. - Linear wire and loop antennas.**
    - Infinitesimal dipole
    - Small dipole, resonant dipole, and monopole
    - Small loop, resonant loop
    - Yagi-Uda antennas
- **Content block 4. - Antenna arrays.**
    - Two-element and N-element arrays
    - Array factor and visible margin
    - Non-uniform amplitude arrays
    - Non-uniform phase arrays and phased arrays
- **Content block 5. - Aperture and patch antennas**
    - Infinitesimal aperture
    - Rectangular aperture
    - Horns
    - Patch antennas
- **Content block 6. - Reflector antennas and antenna measurements**
    - Parabolic reflectors
    - F/D ratio, illumination efficiency and spillover
    - Off-set and Cassegrain reflectors
    - Antenna measurement principles

6. Methodology

Radio-communications will be based on a hand-on methodology that will keep classroom sessions to a minimum, and will base most of the learning activities on laboratory work, following the "learning by doing" principle.

6.1. Classroom sessions

There will be a reduced number of classroom session, in which only the most fundamental topics will be covered, leaving the details for the laboratory sessions. Classroom sessions will be two-hour long. There will be only five classroom session, one

as an introduction, and one dedicated to each of the four content blocks (see the activity planning below).

For each classroom sessions, reading from the course textbook will be recommended. It is important to have read this material before the class. During the classroom sessions the teacher will pose questions relative to the recommended readings, and problems will be solved. Attendance and active participation by the students is expected, and will be evaluated.

6.2. Laboratory sessions

The laboratory sessions will be used to complete the three laboratory assignments. Laboratory sessions will be two-hour long. There will be 10 laboratory sessions in which the professor will be present. The laboratory session will be organized in smaller groups, to be able to have a higher degree of interaction between the professor and the students. The students are welcome to use the lab in the sessions for which a different group is scheduled, in an "open lab" mode, during which the professor will give priority to the students of the groups scheduled for that session.

During the laboratory sessions there will be work on software simulation, building antenna prototypes, measuring these prototypes, and building simple communication links with them.

During the laboratory sessions the teacher will pose questions to the students. Active participation by the students is expected, and will be evaluated. As mentioned above, attendance is not only expected, but required, and more than two unjustified missed laboratory session will entail failing the course, even in July, and having to take it all over again the following year.

6.3. Invited speakers and visits

During the course two speakers, chosen among the most prominent professionals in the field, will be invited to give a presentation to the class. Attendance and active participation by the students is expected, and will be evaluated.

Additionally, one visit may be organized to a company or site relevant for the course. Given that a maximum number of visitors is usually imposed, only those student with a higher grade in the mid-term exam will be allowed to participate. Attendance to this visit will be optional, and it will not be evaluated.

6.4. Office hours

The teachers will publish the office hours during which the students will be able to resolve questions or difficulties encountered during the course.

7. Bibliography

The following textbook will be considered the basic bibliographic reference for the course, from which readings will be recommended for each of the classroom sessions:

- Balanis, C., "Antenna theory : analysis and design", John Wiley & Sons, Inc., 2005.

An additional textbook, with very similar content, that can be used as a back-up is the following:

- Cardama, A. et al., "Antenas", Edicions UPC, 2002.

8. Activity planning

The following is a plan of activities for the course, detailing, session by session whether there is a classroom session, a laboratory session, an open lab, or a quiz, and its content. Next to each classroom session, there is the recommended reading. The plan also details when the lab assignments will be published, and when they are due. At the

end, the total number of hours to be dedicated to this course are detailed, totalling 100, out of which only 36 are of mandatory attendance.

Week	Day		Time	Code	Group	Type	Topic	Recommended reading	Lab report Published	Lab report Due
1	Tuesday, 25 Sep, 2012									
	Wednesday, 26 Sep, 2012	1	12:30-14:30	T	101-3	Classroom	Introduction		Lab 1	
	Thursday, 27 Sep, 2012	2	10:30-12:30	T	101-3	Classroom	1. Antenna parameters. Antenna Radiation pattern.	1.1-1.4, 2.1-2.5, 2.7-2.16		
2	Tuesday, 02 Oct, 2012	3	08:30-10:30							
	Wednesday, 03 Oct, 2012	4	12:30-14:30							
	Thursday, 04 Oct, 2012	5	10:30-12:30							
3	Tuesday, 09 Oct, 2012	6	08:30-10:30	P	101	Laboratory	Lab 0: Wire mesh simulation and optimization SW			
	Wednesday, 10 Oct, 2012	7	12:30-14:30	T	101-3	Classroom	2. Link power calculations. Antenna temperature and SNR.	2.17-2.18		
	Thursday, 11 Oct, 2012	8	10:30-12:30	P	103	Laboratory	Lab 0: Wire mesh simulation and optimization SW			
4	Tuesday, 16 Oct, 2012	9	08:30-10:30	P	101	Laboratory	Lab 1: Wire antennas (1 of 3)			
	Wednesday, 17 Oct, 2012	10	12:30-14:30	T	101-3	Classroom	3. Linear wire and loop antennas.	4.1-4.7, 5.1-5.3, 10.3		
	Thursday, 18 Oct, 2012	11	10:30-12:30	P	103	Laboratory	Lab 1: Wire antennas (1 of 3)			
5	Tuesday, 23 Oct, 2012	12	08:30-10:30	P	101	Laboratory	Lab 1: Wire antennas (2 of 3)		Lab 2	
	Wednesday, 24 Oct, 2012	13	12:30-14:30	T	101-3	Classroom	4. Antenna arrays.	6.1-6.8		
	Thursday, 25 Oct, 2012	14	10:30-12:30	P	103	Laboratory	Lab 1: Wire antennas (2 of 3)			
6	Tuesday, 30 Oct, 2012	15	08:30-10:30	P	101	Laboratory	Lab 1: Wire antennas (3 of 3)			
	Wednesday, 31 Oct, 2012	16	12:30-14:30	P	103	Laboratory	Lab 1: Wire antennas (3 of 3)			Lab1
	Thursday, 01 Nov, 2012	17	10:30-12:30							
7	Tuesday, 06 Nov, 2012	18	08:30-10:30	P	101	Laboratory	Lab 2: Patch antennas (1 of 3)			
	Wednesday, 07 Nov, 2012	19	12:30-14:30	E	101-3	Quiz	5. Aperture and patch antennas	12.1-12.5, 13.1-13.6, 14.1-14.5		
	Thursday, 08 Nov, 2012	20	10:30-12:30	P		Laboratory	Lab 2: Patch antennas (1 of 3)			
8	Tuesday, 13 Nov, 2012	21	08:30-10:30	P	101	Laboratory	Lab 2: Patch antennas (2 of 3)		Lab 3	
	Wednesday, 14 Nov, 2012	22	12:30-14:30							
	Thursday, 15 Nov, 2012	23	10:30-12:30	P	103	Laboratory	Lab 2: Patch antennas (2 of 3)			
9	Tuesday, 20 Nov, 2012	24	08:30-10:30	P	101	Laboratory	Lab 2: Patch antennas (3 of 3)			
	Wednesday, 21 Nov, 2012	25	12:30-14:30	T	101-3	Classroom	6. Reflector antennas and antenna measurements	15.4, 16.1-16.9		
	Thursday, 22 Nov, 2012	26	10:30-12:30	P	103	Laboratory	Lab 2: Patch antennas (3 of 3)			Lab 2
10	Tuesday, 27 Nov, 2012	27	08:30-10:30	P	101	Laboratory	Lab 3: Reflector antennas (1 of 2)			
	Wednesday, 28 Nov, 2012	28	12:30-14:30	S	101-3		Presentation TBD			
	Thursday, 29 Nov, 2012	29	10:30-12:30	P	103	Laboratory	Lab 3: Reflector antennas (1 of 2)			
11	Tuesday, 04 Dec, 2012	30	08:30-10:30	P	101	Laboratory	Lab 3: Reflector antennas (2 of 2)			
	Wednesday, 05 Dec, 2012	31	12:30-14:30	S	101-3		Presentation TBD			
	Thursday, 06 Dec, 2012	32	10:30-12:30	P	103	Laboratory	Lab 3: Reflector antennas (2 of 2)			Lab 3

T	12	(Teoria) Classroom
P	18	(Pràctiques) Laboratory
S	4	(Seminaris) Presentations by guest speakers.
E	2	(Examen) Quizzes.
Subtotal	*36*	*Mandatory attendance hours*
R	24	Reading hours at home
L	16	Open lab sessions (during the other group's lab)
Q	24	Quizz and exam study hours
Total	**100**	**Total effort in hours**