Helsinki University of Technology **17.1.2006/sgh**
Communications Laboratory

S-72.3220 Radio Communication Systems (3 credits (op))
Course presentation, Period III, 2005 – 6

Course status: This course is a compulsory course in the option Radio Communication Systems of the Master's major subject Radio Communications on the degree program of Communications Engineering and in the option Radio Communication Systems of the Master's major subject Communications Applications in the degree program of Electronics and Electrical Engineering. Together with the course S-72.3210 Channel Modelling for Radio Communication Systems it will replace the old courses S-72.135 Fixed Radio Networks and S-72.232 Radio Communication Systems. It is also a compulsory course in the curriculum of the Radio Communications option in the International Master's Program in Communications Engineering.

Course motivation and targets: Radio has played an important role in telecommunications since the first trials about 110 years ago. In many applications radio is due to easy construction a very competitive transmission technology compared to wired solutions. For mobile communications radio is the only practical technology. For point to area communications like audio and video broadcasting the main technology has been and still is radio. Planning radio systems is because of the time-variant nature of the radio propagation channel sometimes a rather complex task. The starting point is the planning of the physical transmission link using a radio system, which includes base-band and RF parts of the radio transceivers, antennas and feeders, and the radio path. Also the radio network planning to obtain good spectrum efficiency in a interference environment is an important topic.

After the course the student will have knowledge about

- typical radio communication systems and environments,
- radio noise and equipment impairments,
- radio link budget and system planning.

The main goal is to provide information for radio link budget calculations in radio link and network planning, so that the student is able to choose system solutions, which will guarantee that the radio communication system will fulfil given specifications.

The radio link budget is a simple instrument for this purpose, but the determination of the gains and losses in the different terms of the budget will require knowledge of the performance of the different transmission methods.

The application of it to system planning requires understanding of the interactions between the used transmission methods and algorithms.

Prerequisites: The courses S-72.420/S-72.1140 Transmission Methods in Telecommunication Systems (4 credits(ov)/5 ECTS-credits(op)), S-72.3210 Channel Modelling for Radio Communication Systems (3 credits (op)), and S-72.3230 Radio Transmission and Network Access (3 credits (op)) or equivalent courses are assumed to be acquired before this course.

Lectures and exercises: These are held weekly at the following times in Period III, spring term 2006:

Tuesdays 14 – 16,
Wednesdays 14 – 16,
Thursdays 14 – 16.

The lecture plan is attached. Possible changes are announced on the course homepage (http://www.comlab.hut.fi/opetus/3220/index.html) and on the information board on floor E3.
In the exercises demonstrative problems and solving methods are presented. In each exercise one homework is given, which should be returned for checking and grading. The scores will have an impact on the final course grade.

Teacher: The course is lectured by professor Sven-Gustav Häggman, who is the responsible teacher of this course. The exercises are also held by him.

Contents:
1. Radio spectrum issues
2. Typical radio communication systems
3. Radio noise
4. Transceiver non-idealities
5. Concept of radio link budget
6. Application of radio link budget to radio system planning

The lecture plan is given below. If needed, the plan may be changed.

Requirements: The course is carried out by an exam. The exam requirements consist of the material distributed to the students. There will be two exams, the first exam is on March 7, 2006, and the second exam will be on May 16, 2006.

The exam consists of two parts. The first part is done with closed books, and it comprises two tasks where general principles, definitions etc. are asked for. After the answers have been given to the exam supervisor, the three problem-oriented tasks of the second part are given to the student. This is a open-book part, where the use of arbitrary source material is allowed except for team work between the students or other persons. Use of scientific calculators is allowed and recommended.

Final grade: The final course grade is calculated from the formula:

$$\text{Final grade} = T_{\text{exam}} + 0.2T_{\text{exercises}}$$

The student must pass the exam.

Literature:

[1] Lecture and exercise material.

Corresponding material can partly be found from the following books (which also contain a lot of topics not included in this course):

[2] A.B. Carlson, P.B. Crilly, J.C. Rutledge: Communications systems. An introduction to signals and noise in electrical communication. 4th ed. Mc Graw-Hill 2002, 850p.

[2] S. Haykin: Communication systems. 3rd ed. Wiley 1994, 872p.

[3] J.G. Proakis: Digital Communications, 4th ed. Mc Graw-Hill, 2001, 1002p.

[4] L. Ahlin, J. Zander: Principles of Wireless Communications. Lund 1997, Studentlitteratur, 527p.

[5] S. Haykin, M. Moher: Modern Wireless Communications, Prentice Hall 2004, 560p.

The books are not necessary for carrying out the course. Books [1] and [2] are intended as first-level books on communications, The books by Ahlin and Zander [4] and Haykin and Moher [5] correspond quite well to our approach, but will, however, only partly cover this course.

S-72.3220 Radio Communication Systems (3 ECTS-credits), 24+12h
Lecture plan 2006

Tu	17.1.	14 – 16	Lecture 1 Lecture 2	Introduction Basic principles of radiocom systems
Wed	18.1.	14 – 16	Lecture 3 Lecture 4	Examples of radiocom system Examples of radiocom system
Thu	19.1.	14 – 16	Exercise 1 Exercise 2	
Tu	24.1.	14 – 16	Lecture 5 Lecture 6	Examples of radiocom system Examples of radiocom system
Wed	25.1.	14 – 16	Lecture 7 Lecture 8	Radio noise Radio noise
Thu	26.1.	14 – 16	Exercise 3 Exercise 4	
Tu	31.1.	14 – 16	Lecture 9 Lecture 10	Radio noise Radio noise
Wed	1.2.	10 – 12	Lecture 11 Lecture 12	Transmitter nonlinearity Receiver nonidealities
Thu	2.2.	14 – 16	Exercise 5 Exercise 6	
Tu	7.2.	14 – 16	Lecture 13 Lecture 14	Concept of radio link budget Concept of radio link budget
Wed	8.2.	14 – 16	Lecture 15 Lecture 16	Low-capacity ptp radio system planning Low-capacity ptp radio system planning
Thu	9.2.	14 – 16	Exercise 7 Exercise 8	
Tu	14.2.	14 – 16	Lecture 17 Lecture 18	Low-capacity ptp radio system planning Low-capacity ptp radio system planning
Wed	15.2.	14 – 16	Lecture 19 Lecture 20	High-capacity ptp radio system planning High-capacity ptp radio system planning
Thu	16.2.	14 – 16	Exercise 9 Exercise 10	
Tu	21.2.	14 – 16	Lecture 21 Lecture 22	High-capacity ptp radio system planning High-capacity ptp radio system planning
Wed	22.2.	14 – 16	Lecture 23 Lecture 24	Broadcast system planning Satellite link planning
Thu	23.2.	14 – 16	Exercise 11 Exercise 12	
Tu	28.2.	14 – 16	Spare time	
Wed	1.3.	14 – 16	Spare time	
Thu	2.3.	14 – 16	Spare time	