S-72.3220 Radio Communication Systems

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Teaching and Research Area: Radio Communication Systems, especially Mobile Communication Systems

S-72.3220 Radio Communication Systems (3 ECTS credits)
Course presentation, spring term 2008

Course status in the new degree structure:

- Radio Communication Systems is a compulsory course in the option Radio Communication Systems of the Master's major subject Radio Communications in the degree program of Communications Engineering
- It is an optional course in the option Radio Communication Systems of the Master's major subject Communications Applications in the degree program of Electronics and Electrical Engineering.
- It is also a compulsory course in 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.
- Due to easy construction radio is a very competitive transmission technology compared to wired solutions in many applications.
- 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.
- Because of the time-variant nature of the radio propagation channel planning of radio systems is sometimes a rather complex task.
- Also radio network planning for obtaining good spectrum efficiency in a interference environment is an important topic.
- Starting point: the implementation of the physical transmission link with a radio system, which includes base-band and radio transceivers, antennas and feeders, and the radio path.
- 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.

- **After the course the student knows**
  - **typical radio communication systems and environments,**
  - **radio noise and equipment impairments,**
  - **radio link budget and system planning.**
- **The radio link budget is a simple instrument for this purpose,**
  - **determination of the gains and attenuations of the different terms in the budget will require deep knowledge of the performance of the different transmission methods,**
  - **application of it to system planning requires deep understanding of the interactions between the used transmission methods and algorithms.**

Prerequisites:

- **S-72.1140 Transmission Methods in Telecommunication Systems or its equivalent**
- **S-72.3210 Channel Modelling for Radio Communication Systems**

Lectures and exercises:

- **These are held weekly at the following times in Period III, 2008:**

Period III	
• **Wednesdays 10 – 12, F201** • **Wednesdays 14 – 16, S2** • **Thursdays 12 – 14, F201**	

- **Starting at January 17.**
- **The lecture plan is attached. Possible changes are announced on the course homepage (http://www.tll.tkk.fi/Studies/S-72.3220/) and on the information board on floor E3.**
- **In the exercise demonstration problems and solving methods are presented. In each exercise a home work is given, which should be returned for checking and grading. The scores will have an impact on the course grade.**
- **Deadline for submission of homework solutions: March 3, 2008 at 12:00 sharp. Later submissions will not be graded.**
- **Homework solutions should be delivered into a cabinet marked with the course code. Location in wing E.**

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. There will be two exams**
  - **The exam requirements consist of the material distributed to the students.**
  - **The first exam is on March 7, 2008, 9 – 12, S3 and the second exam is on May 9, 2008, 9 – 12, S3.**
- **The exam consists of two parts.**
  - **The first part is done without source material, and it comprises two tasks where general principles, definitions etc. are asked for.**
  - **After the answers have been given to the exam monitor, the four problem-oriented tasks of the second part are given to the student. In this part the use of arbitrary source material is allowed except for team work between the students or other persons. The three best tasks are considered for the exam grade**

- **Final grade: The final course grade is calculated with the formula:**

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

- **The exam grade should be accepted (≥0.5).**

Literature:

[1] Lecture and exercise material (will be distributed through Edita).

Relevant material can be found from the following books:

[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.

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

[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. [2] and [3] are entry-level books on communications, while [4] and [5] are entry level books on radio communications. [5] is best corresponding to this course, but will only partly cover it.

S-72.3220 Radio Communication Systems (3 ECTS-credits), 24+12h
Lecture plan 2008

Thu	17.1.	14 – 16 F201	Lecture 1 Lecture 2	Introduction Basic principles of radiocom systems
Wed	23.1.	10 – 12 F201	Lecture 3 Lecture 4	Examples of radiocom system Examples of radiocom system
Wed	23.1.	14 – 16 S2	Exercise 1 Exercise 2	
Thu	24.1.	12 – 14 F201	Lecture 5 Lecture 6	Radio noise Radio noise
Wed	30.1.	10 – 12 F201	Lecture 7 Lecture 8	Radio noise Transceiver non-idealities
Wed	30.1.	14 – 16 S2	Exercise 3 Exercise 4	
Thu	31.1.	12 – 14 F201	Lecture 9 Lecture 10	Concept of radio link budget Concept of radio link budget
Wed	6.2.	10 – 12 F201	Lecture 11 Lecture 12	Typical values of terms in the radio link budget
Wed	6.2.	14 – 16 S2	Exercise 5 Exercise 6	

Thu	7.2.	12 – 14 F201	Lecture 13 Lecture 14	Low-capacity ptp radio system planning Low-capacity ptp radio system planning
Wed	13.2.	10 – 12 F201	Lecture 15 Lecture 16	Low-capacity ptp radio system planning Low-capacity ptp radio system planning
Wed	13.2.	14 – 16 S2	Exercise 7 Exercise 8	
Thu	14.3.	12 – 14 F201	Lecture 17 Lecture 18	High-capacity ptp radio system planning High-capacity ptp radio system planning
Wed	20.2.	10 – 12 F201	Lecture 19 Lecture 20	High-capacity ptp radio system planning High-capacity ptp radio system planning
Wed	20.2.	14 – 16 S2	Exercise 9 Exercise 10	
Thu	21.2.	12 – 14 F201	Lecture 21 Lecture 22	NLOS radio system planning NLOS radio system planning
Wed	27.2.	10 – 12 F201	Lecture 23 Lecture 24	Broadcast system planning Satellite link planning
Wed	27.2.	14 – 16 S2	Exercise 11 Exercise 12	
Thu	28.2.	12 – 14	Spare time	
Wed	5.2.	10 – 12	Spare time	