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 2006

Course status in the old degree structure:

- Radio Communication Systems can be included as a compulsory course in the major/minor subject Communication Systems
- It is an optional course in the major/minor subjects Radio Engineering and Signal Processing for Communications.
- It is also included in the curriculum of the International Master's Program in Telecommunications.

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-72.245/S-72.1140 Transmission Methods in Telecommunication Systems**
- **S-72.3210 Channel Modelling for Radio Communication Systems**
- **S-72.3230 Radio Transmission and Network Access**

Lectures and exercises:

- **These are held weekly at the following times in Period III, 2006:**

  - **Tuesdays 14 – 16, S5**
  - **Wednesdays 14 – 16, S2**
  - **Thursdays 14 – 16, S2**

- **The lecture plan is attached. Possible changes are announced on the course homepage (http://www.comlab.hut.fi/studies/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.**

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, 2006, and the second exam is on May 16, 2006.**
- **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 three 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.**

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

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

- **The exam grade should be accepted.**

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] J.G.Proakis: Digital Communications, 3rd ed. Mc Graw-Hill, 1995, 912p.

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

[6] I.A.Glover, P.W.Grant: Digital Communications, Prentice Hall 1998, 734p.

[7] S. Benedetto, E.Biglieri: Principles of digital transmission with wireless applications, Kluwer Academic/Plenum Publishers 1999, 855p.

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

The books are not necessary for carrying out the course. [1] and [2] are first-level books on communications, while [4] and [7] go into deeper treatment of different transmission methods, and can also be used in post-graduate studies. [5] and [8] is quite near to this course, but will not fully cover it.