

# Final exam in Modern Wireless Systems - LTE and Beyond (ETTN15)



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on October 27, 2014, 08–13.

- During this final exam, you are allowed to use a calculator and the course book.
- Each solution should be written on a separate sheet of paper.  
Please write Your name on each sheet, and number each sheet.
- Show the line of reasoning clearly, and use the methods presented in the course.  
If You use results from the course book, add a reference in Your solution.
- If any data is lacking, make reasonable presumptions.

**Good Luck!**

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## Problem 1:

Determine for each of the five statements below if it is true or false.

*Observe! As always, motivations to your answers should be given.*

- “In LTE Rel-10 uplink bit rates up to 600 Mbps can be obtained within a 40 MHz bandwidth.”
- “The MBSFN reference symbol that is sent in a specific resource element is the same from each base station in the MBSFN area.”
- “In LTE master information is located in time directly after the PSS.”
- “In LTE the use of multiple transmit antennas always assumes that the transmitter knows the channel characteristics”.
- “In LTE all downlink control signals are sent in the control region in the OFDM time-frequency grid.”

**Problem 2:**

Consider in a) and b) below downlink transmission to Rel-8/9 terminals in LTE, and assume that the normal cyclic prefix is used.

- a) Assume two transmitting antennas and that PCFICH=2. Estimate the maximum user-data carrying coded bit rate that can be communicated within a subframe if the communication bandwidth 15 MHz is used.
- b) Assume four transmitting antennas. Explain in detail what can be obtained in the receivers from the CRS symbol that is sent in the second OFDM interval in a subframe and at subcarrier seven.
- c) Let us here study the peak performance in bit rates for Rel-8/9, and for Rel-11. Explain why the improvement-factor for the uplink in Rel-11 is significantly higher than the improvement-factor for the downlink.

(10 points)

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**Problem 3:**

- a) Explain in detail how, in LTE, the mapping of the PUSCH to the OFDM time-frequency grid is different compared to the mapping of the PDSCH.
- b) An important concept in LTE is channel-state information.
  - i) Explain in detail why channel-state information is important.
  - ii) Explain in detail how channel-state information is obtained.
- c) Explain why transmit diversity is so important in LTE.

(10 points)

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**Problem 4:**

- a) Explain when, and why, the DFT is used in LTE.
- b) A person claims that for uplink data transmissions in LTE Rel-8/9, normally the entire 20 MHz bandwidth can be used. Determine if the person is correct, or not.
- c) In LTE downlink, there are several differences between non-codebook-based precoding and codebook-based precoding.

Explain what differences there are (the more the better), and also explain the consequences of these differences.

(10 points)

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**Problem 5:**

- a) A person claims that a MIMO system with four transmitting antennas and two receiving antennas can always be used to obtain a spatial multiplexing gain equal to two. Determine if the person is correct, or not.
- b) What do we learn from the basic Shannon capacity expression that is relevant when studying the LTE system?
- c) In LTE there are several situations/scenarios in which possible interference needs to be handled. Give examples, the more the better, of such situations/scenarios, and also describe how the interference may be handled.

(10 points)

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