

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



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on October 26, 2016, 14.00–19.00.

- 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 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.*

- “An LTE terminal should typically be able to perform two-antenna reception (at least).”
- “Uplink scheduling grants are transmitted at the edges of the uplink spectrum.”
- “The use of CRS and SRS have some similarities.”
- “In case of NB-IOT, at least three sub-carriers are used in a transmission.”
- “In the context of scalable OFDM numerology, a scale factor 64 would imply a cyclic prefix equal to  $0.074 \mu s$ .”

**Problem 2:**

a) Consider a future UE Category X, with some rel-10 capabilities, with peak rates 750/300 Mbps (DL/UL). Maximum number of transmit antennas is 4, and maximum modulation is 64-QAM.

Give several technical solutions how this can be achieved in the DL, and also several technical solutions for the UL. Clearly explain which solution you recommend in the DL, and also which solution you recommend in the UL.

b)

i) Consider an MBSFN resource-block. Estimate the user data coded bit rate delivered by such a resource-block. Assume 16-QAM.

ii) Consider UL communication from a terminal at the cell-edge.

Explain in detail why, if no counter-measures are made, cell-edge uplink users in neighbouring cells may disturb the uplink communication from the terminal above.

iii) How can a terminal understand where the PRACH resources are located?

(10 points)

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**Problem 3:**

a)

i) Explain in detail, and give examples of applications (the more the better), how carrier aggregation can be used in LTE.

ii) Are there any concerns about PUCCH in the context of carrier aggregation?

b)

i) Some signals in LTE are especially important and require special protection (e.g., extra coding and/or diversity). Give examples (the more the better) of such signals, and also explain the importance of each of them.

ii) Explain what is meant by so-called “DCI formats” (DL and UL), and what they are used for.

iii) Explain some advantages of having the control region in the beginning of the subframe.

(10 points)

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**Problem 4:**

a) To be able to perform DL and UL channel-dependent scheduling, a lot of information is needed.

Explain in detail:

i) what kind of information is needed in LTE (the more the better).

ii) how this information is obtained in LTE (the more the better).

b) Here we study the two structures in Figure 6.17 and Figure 6.19, respectively.

Explain in detail:

i) advantages, the more the better, with the structure in Figure 6.17 on page 121.

ii) advantages, the more the better, with the structure in Figure 6.19 on page 126.

(10 points)

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**Problem 5:**

a) As with any communication system, also LTE has its limitations.

Study the structure of CRS, and explain in detail situations when the LTE-system will stop working as a reliable communication system.

b) The original basic design of LTE (rel-8) was not fully prepared for applications like eMTC, D2D and LBT.

The introduction of these applications in LTE therefore needs special attention, i.e., special additional technical solutions.

Explain, for each application, why it requires special attention.

c) Subframe 0 contains special kinds of signals. Explain in detail the purpose of these signals, and which resources they occupy.

(10 points)

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