MIMO Fundamentals and Signal Processing
Examination for Ph.D. Students
October 2009

Examination in this course consists of homework problems. The homeworks are to be solved, written up and submitted individually. Typesetting the solutions is not necessary, but please spend effort to produce legible handwriting.

This course has a substantial overlap with the PhD course *Fundamentals of Wireless Communications* (FWC) given during HT08. Therefore the examination requirements will be different for students who took FWC and students who did not.

Deadline for submitting the homework solutions: November 27, 2009.

- **Students who did not take the FWC course** during HT08 should solve

  (a) problems P1-P7, P9-P12 and TV-7.1, TV-7.3, TV-7.9, TV-8.1, TV-8.23 of that course,

  and

  (b) problems LS-6.1, LS-6.2, LS-6.7, LS-7.1, LS-7.3, LS-7.4, LS-7.5, LS-9.1, LS-9.4, LS-9.9, LS-9.13, Q1-Q3

  P = additional problems in FWC course, can be found on the web page of the FWC course.
  Q = problems below
  TV = Fundamentals of wireless communications book by Tse/Viswanath
  LS = Space-time block coding book by Larsson/Stoica

  This can give in total 8 ECTS credits.

- **Students who took FWC** during HT08 [and already have solved the problems listed under (a) above] should solve the problems listed under (b) above.

  This can give 4 ECTS credits.

Additional problems:

Q1. Prove the first unnumbered equation in the section titled "Solutions" in the lecture note "MIMO detection methods: how they work".

Q2. In the lecture note on MIMO detection, explain what happens if m<n. Give an example in practice when that happens. More generally, discuss under what circumstances (if any) ML detection is possible for under-determined systems.

Q3. Prove the "Jacobian logarithm" formula

$$\log(e^a + e^b) = \max(a,b) + \log(1+e^{-|a-b|})$$

and explain why it is useful in practice for the evaluation of equation (9) in the lecture notes.