

Fundamentals of Wireless Communications -- spring 2014
Course Outline and Schedule
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Students are expected to read TV-chapters 1, 2 and 4 as preparation for the course.

Part 1: Point-to-point scalar channels and diversity transmission/reception

1. Dec. 18, 2013, 9.00-12.00
Lecture: Introduction to the course. The AWGN channel.

Reading: TV 5.1-5.3
Homework (**to be handed in/presented Jan. 20**): TV-5.1, 5.6, 5.7
2. Jan. 10, 2014, 9.00-12.00
Lecture: Fading point-to-point channels. Receive diversity.

Reading: TV 5.4 + handout on capacity of scalar point-to-point channels.
Homework (**to be handed in/presented Jan. 20**): TV-5.13, 5.14, 5.15, 5.24 (part 1 only), E-1
3. Jan. 20, 2014, 9.00-12.00
Homework session 1
4. Jan. 24, 2014, 9.00-12.00
Lecture: Transmit diversity, linear space-time block codes

Reading: LS 4.1-4.4, 5.1, 6.3, 7.1-7.3, 9.1-9.4
Homework (**to be handed in/presented Feb. 13**): LS-4.1, 5.1, 5.2, 5.6, 5.7, 6.4
5. Jan. 30, 2014, 10.00-13.00
Lecture: Orthogonal space-time block codes

Reading: LS 7.4
Homework (**to be handed in/presented Feb. 13**): LS-7.3, 7.5, 9.13, 9.14, E-2, E-3
6. Feb. 14, 2014, 13.00-16.00
Homework session 2

Part 2: MIMO and multiuser communications

7. Date: Feb. 19, 2014, 9.00-12.00
Lecture: Point-to-point MIMO channel, spatial multiplexing architectures

Reading: TV-7.1, 8.1, 8.2, 8.3, 8.4, 8.5 + handout on capacity on MIMO channels

Homework (**to be handed in/presented March 7**): 8.1, 8.9, 8.10, 8.16, 8.23 (see note about misprints below), E-4

8. Date: Feb. 27, 2014, 9.00-12.00
Lecture: MIMO channel modeling

Reading: TV-7.2, 7.3

Homework (**to be handed in/presented March 7**): TV-7.1, 7.3, 7.9

9. Date March 7, 2014, 13.00-16.00
Homework session 3

10. Date: March 11, 2014, 13.00-16.00
Lecture: MIMO detection fundamentals

Reading: Handout

Homework (**to be handed in/presented April 25**): E-5, E-6

11. Date: March 27, 9.00-12.00
Lecture: Multiple-access channels

Reading: TV-6.1, 6.3, 10.1, 10.2 + handout on the SIMO-MAC

Homework (**to be handed in/presented April 25**): TV-6.1, TV-6.2, TV-10.4

12. Date: April 7, 13.00-16.00
Lecture: Broadcast channels

Homework (**to be handed in/presented April 25**): E-7

Reading: TV-6.2, 6.4, 10.3, 10.4, 10.5 + handout on the SIMO-BC

13. Date: April 15, 9.00-12.00
Lecture: Specific techniques for broadcast channels (this lecture given by Doc. Daniel Persson)

Reading and homework (**to be handed in/presented April 25**): See the document entitled “Practical beamforming lecture, Reading and exercises”, available on the course webpage

14. Date: April 25, 9.00-12.00
Homework session 4

Part 3: Massive MIMO

This part will be based on the online tutorial. The final course session will take place on June 16, from 13.00-16.00

Students are expected to study all material listed under “reading”. Only selected parts of the material will be covered in the lectures.

Extra homework problems:

E-1) Numerically compare and plot (3.24) and (3.25) in the handout as functions of $1/\sigma$ for a) Rayleigh fading; h circularly Gaussian distributed with unit variance, and b) Ricean fading; $h=1+h'$ where h' is circularly Gaussian distributed with unit variance. Comment on the result.

E-2) In lecture 3, work out the MMSE estimate $E[H|Yp]$

E-3) In lecture 3, work out the noncoherent (averaged) likelihood function $p(Y|X)$ for noncoherent detection of linear space-time block codes

E-4) Show that if H is positive definite, then $[H^{-1}]_{k,k} \geq 1/H_{k,k}$. Explain the implications in terms of performance for the ZF receiver (decorrelator).

E-5) Consider MIMO detection with BPSK modulation per real dimension. Show how to write $e^{-|y-Hs|^2} * P(s)$ as $e^{-|...|^2}$ where $|...|^2$ is a quadratic form in s . Explain the consequences. (Consulting the literature is OK.)

E-6) Consider optimal MIMO detection when H is unknown, but an estimate H' is known; where H and H' are jointly Gaussian. When is this a reasonable model? Explain the consequences of the result. (Consulting the literature is OK.)

E-7) In the BC-capacity proof in the printed handout distributed on March 27, explain where and why conjugate transpose should be replaced by regular transpose. (This was a misprint.)

Note about misprints:

In exercise 8.23 (at least in my printing of the book), there seems to be a misprint: R should be replaced by $R/(nr*nt)$ in (8.127), (8.128), (8.129)

In the handout on BC-capacity, in Eq. (3.69), $\rho_{d,2}$ should be q_2 (twice).