

TELE9753

Advanced Wireless Communications

THE UNIVERSITY OF
NEW SOUTH WALES



School of Electrical Engineering
and Telecommunication

COURSE INTRODUCTION — Session 1, 2009

Course Staff

Course conveners: A/Prof. Jinhong Yuan, room EE324B
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Consultations: Students are encouraged to use the open consultation hour rather than contact by email; students may seek consultation with the course convener at other times by appointment. Appointment can be made during regular lecture breaks (e.g. during breaks between 6pm-9pm on Monday class) in the first instance, rather than by email.

Consultations: Mondays, 5pm–6pm, room EE324B

Course details

Credits: The course is a 6 UoC course; expected workload is 9-10 hours per week throughout the 12 week session.

Contact hours: The course consists of 3 hours of per week, comprising lectures, and tutorials or laboratory (a typical class might be 2 hours of lecture followed by 1 hour of tutorial. In addition 2 hours of lecture followed by 1 hour of lab is another option.):

Lectures: Mondays, 6pm–8pm, MechEng502

Tutorial: Mondays, 8pm-9pm, MechEng502

(Option: Lab sessions: will be discussed in the first Lecture. Lab room is EE322. Starting week for Laboratory classes will be informed in the first lecture.)

Course Information

Context and aims

This course provides advanced knowledge of wideband wireless communication techniques. It include the areas of diversity: Time diversity, Space diversity, Frequency

diversity; Wideband CDMA systems, Wideband OFDM systems, antenna arrays, MIMO channel modeling in the angular domain and statistical models, smart antennas techniques, multiple-input/multiple-output communications systems, spatial multiplexing, space-time processing and coding; and multiuser detection and receiver designs, multiple access and interference management, opportunistic communication, multiuser waterfilling.

This course provides advanced knowledge of wideband wireless communication systems. It include the areas of:

- Diversity: Time diversity, Space diversity, Frequency diversity
- Wideband CDMA systems
- Wide OFDM systems
- Smart antennas techniques
- multiuser detection and receiver designs

Aims: This course aims to:

- a. Make the student familiar with the theories of information transmission in wireless channels.
- b. Make the student familiar with wideband techniques and their applications.
- c. Enable the student to do analysis and design multiuser detection algorithms.

Relation to other courses

This course provides advanced knowledge of wideband wireless communication techniques to enable the students to design advanced wireless communication systems. It includes the topics of diversity techniques, multiple access and interference management, Wideband CDMA, Wideband OFDM, antenna arrays, multiple-input/multiple-output communications, spatial multiplexing, space-time processing and coding; and multiuser detection, opportunistic communication, multiuser waterfilling. It serves as an excellent basis from which to commence research in the area. Various aspects of the course bring students up to date with the very latest developments in the field, as seen in recent international conferences and journals, and some of the laboratory work is designed in the style of an empirical research investigation. TELE9753 is also well complemented by ELEC9754 Coding and Information Theory, which gives an insight into advanced knowledge of error control coding technique and theories of information transmission mainly at the physical layer. It is recommended for future study.

Pre-requisites: The minimum pre-requisite for the course is TELE3113, Analogue and Digital Communications (or equivalent). Knowledge from TELE4651 and TELE4653 is highly desirable.

Assumed knowledge: It is essential that you are familiar with the digital communications, modulation/demodulation, channel coding/decoding, matched filter receiver, coherent and non coherent detections, random signals and processing, fading

TELE9753 Advanced Wireless Communications

channels, bit error rate analysis. Students who are not confident in their knowledge from previous digital communications courses (especially the topics mentioned) are strongly advised to revise their previous course materials as quickly as possible to avoid difficulties in this course.

Previous course code: The course replaces previous course TELE9353 Cellular Mobile Communications.

Learning outcomes

On successful completion you should be able to:

1. Understand of the principles, algorithms and technologies used in transmission information in wireless mobile channels
2. Derive expressions for error performance and capacity for various transmission schemes covered in the lectures
3. Explain the operation of example algorithms covered in lectures, and discuss the effects of varying parameter values within these;
4. Analyze the performance of a wireless communication systems
5. Apply the principles and technique to communication systems design or undertake further research

The course delivery methods and course content address a number of core UNSW *graduate attributes*; these include:

- a. The capacity for analytical and critical thinking and for creative problem-solving, which is addressed by the tutorial exercises and laboratory work.
- b. The ability to engage in independent and reflective learning, which is addressed by tutorial exercises together with self-directed study.
- c. The skills of effective communication, which are addressed by the viva-style verbal assessment in the laboratory.
- d. Information literacy, which is addressed by the homework.

Please refer to <http://www.ltu.unsw.edu.au/content/userDocs/GradAttrEng.pdf> for more information about graduate attributes.

Teaching strategies

The course consists of the following elements: lectures and tutorials, and home works. If possible we will introduce some lab session based on MATLAB software.

Lectures

During the lectures, techniques for the analysis and design of the various transmit and receiving scheme will be presented. The lectures provide you with a focus on the core

material in the course, together with qualitative, alternative explanations to aid your understanding. Various examples will be given, to enrich the analytical course content. The lectures materials distributed in class will give a basic guide to the course syllabus, but you will need to supplement them with additional reading, of the recommended text book and/or other materials recommended by the lecturing staff. In particular, you should not assume that attendance at all lectures (even with a glance or two through the notes), on its own, is sufficient to pass the course.

Home work and Problem sheets

The lectures can only cover the course material to a certain depth; you must read the textbook(s) and reflect on its content as preparation for the lectures to fully appreciate the course material. Home preparation provides you with the background knowledge you will need. The problem sheets aim to provide in-depth quantitative and qualitative understanding of wireless communications theory and methods. Together with your attendance at classes, your self-directed reading, completion of problems from the problem sheet and reflection on course materials will form the basis of your understanding of this course.

Assessment

Mid-session exam: 30%
 Final examination: 70%

Mid-session examination: The mid-session examination tests your general understanding of the course material, and questions may be drawn from any course material up to the end of week 6. It is usually scheduled in Week 7, lecture time. It is closed-book test. Grades will be assigned according to the understanding of each topic/question/technical. This is related to learning outcomes 1 and 2.

Final examination: The exam in this course is a standard closed-book 3 hours written examination, comprising four-to-six compulsory questions. University approved calculators are allowed. The examination tests analytical and critical thinking and general understanding of the course material in a controlled fashion. Questions may be drawn from any aspect of the course, unless specifically indicated otherwise by the lecture staff. Please note that *you must pass the final exam in order to pass the course*. This is related to learning outcomes 3, 4 and 5.

Course Schedule

Week	Lecture	Ref
0 Mar 4 th	No lecture	
1	Introduction to wireless channel	[1]
2	Detection and Diversity in Fading channels	[1]
3	Time diversity and Antenna diversity	[1]
4	Cellular System, multiple access	[1]
5	Interference management	[1]

6	Wideband CDMA and OFDM	
7, Apr 29 th	Mid-session examination, duration 1-1.5 hours Capacity	
8	Capacity of fading channels	[1]
9	Multiuser capacity	[1]
10	Opportunistic communications	[1]
11	MIMO systems	[2]
12	MIMO systems	[2]

Resources

Textbooks

Prescribed textbook

The following textbook is prescribed for the course:

- [1] David Tse and Pramod Viswanath, *Fundamentals of Wireless Communication*, Cambridge University Press, 2005.

You may want to check the coverage of this text before purchasing, as some topics in the syllabus are not featured. Unfortunately there is no single text that covers all topics in a satisfactory depth. Additional references, listed below and at the end of some lecture note sets, will in combination provide complete coverage of the course. Lecture notes will be provided, however note that these do not treat each topic exhaustively and additional reading is required.

Reference books

The following books are good additional resources for MIMO topics:

- [2] B. Vucetic and J. Yuan: *Space-time coding: John Wiley and Sons*, 2003

On-line resources

Some additional on-line resources relevant to the course:

Library resources <http://info.library.unsw.edu.au/web/services/teaching.html>

Other Matters

Academic Honesty and Plagiarism

Plagiarism is the unacknowledged use of other peoples work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a serious offence by the University and severe penalties may apply. For more information about plagiarism, please refer to <http://www.lc.unsw.edu.au/plagiarism>

Continual Course Improvement

The course is under constant revision in order to improve the learning outcomes of its students. Please forward any feedback (positive or negative) on the course to the course convener or via the Course and Teaching Evaluation and Improvement Process (surveys at the end of the course).

Administrative Matters

On issues and procedures regarding such matters as special needs, equity and diversity, occupational health and safety, enrolment, rights, and general expectations of students, please refer to the School policies, see <http://scoff.ee.unsw.edu.au/>.