Course Staff

Lecturer:

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Laboratory demonstrator:

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Giovanni.Geraci@yahoo.it

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 11-13 on Monday class) in the first instance, rather than by email.

Consultations: Monday, 2pm–3pm, room EE324B

Course details

Credits: The course is a 6 UoC course; expected workload is 9-10 hours per week throughout the 13 week session.
Contact hours: The course consists of 2 hours of per week, comprising 2-h lectures, and 2-h tutorials or 3-h laboratory every fortnight:

Lecture Times

Monday 11-13, Quad G026

Tutorials

A tutorial must be attended every week. The tutorial sheets will be distributed by the lecturer. Tutorials begin in week 2.

Monday 9-11, Quad G026

Laboratory

The laboratories are all in EE322, performed on PCs with MATLAB. Preparation is essential before each laboratory, and there will be an assessment for your preparation at the start of each lab, mainly to check whether your have prepared your programs for each lab.

Lab Times can be found in school website:

Tuesday 9-12

Please come to the lab time you are enrolled in.

The Labs must be attended every second week starting from week 2. There are 5 labs to complete in total, and students must get marked by a demonstrator before the end of each lab session. A satisfactory performance in the lab component is a requirement of passing this course.

Course information

Context and aims

This is an advanced course in telecommunications, providing detailed knowledge of the fundamental concepts in wireless communications and in-depth discussions on several selected areas, namely, error control methods, antenna diversity techniques, wideband transmissions. This course is a professional elective offered in the Telecommunication option. It assumes basic competency in the second year electronics and systems courses and the third year TELE3113 Introduction of Analogue and Digital Communications, and requires a mathematical ability of at least up to second year.

Syllabus

Wireless Communications Channels: time-variant multipath fading, Doppler shift, fade rate, shadowing effect, time selective channel, frequency selective channel, the effects of fading on wireless transmission, performance analysis. Digital Transmission over Fading
Channels: performance analysis, burst-error correcting codes for fading channels, convolutional codes, soft output Viterbi algorithm, coded modulation, turbo principles, iterative processing, space diversity, time diversity and frequency diversity techniques. Wideband Transmissions: spread-spectrum communications, DS-CDMA, frequency hopping, OFDM techniques, their applications.

Aims: This course aims to:

a. Make the student familiar with the basic principles of information transmission in wireless channels.
b. Make the student familiar with wireless transmission techniques and their applications.
c. Enable the student to do analysis and design transmission and receiving algorithms.

Course Objectives

At the end of this course the student:

- be familiar with wireless channel models and the effects of fading on the transmitted signals.
- have developed an understanding of various diversity techniques.
- have developed an understanding of error control methods for wireless channels.
- have developed an understanding of wideband transmission technologies.

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.

Pre-requisites: The minimum pre-requisite for the course is TELE3113, Analogue and Digital Communications (or equivalent). Knowledge from 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 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 TELE4333 Wireless 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, tutorials, labs, and home works. Lab sessions are 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 textbook 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**

**Assessment**

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labs</td>
<td>15%</td>
<td>(at 3 marks for each of labs 0-4)</td>
</tr>
<tr>
<td>Lab preparation</td>
<td>5%</td>
<td>(at 1 mark for each of labs 1-4)</td>
</tr>
<tr>
<td>One Class Test</td>
<td>20%</td>
<td>(In the lecture, TBA)</td>
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<tr>
<td>Project</td>
<td>20%</td>
<td>(TBA)</td>
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<tr>
<td>Exam</td>
<td>40%</td>
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**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.

**Individual project**: The project examination tests your general understanding of a particular technique and its performance in wireless communications, which you have studied in the course material. The project is usually given in Week 7 or Week 8, lecture time. You need to hand-in before week 11 or week 12. Grades will be assigned according to the project report, results, discussions, programs. This is related to learning outcomes 1, 2, 3, 4 and 5.

**Possible project topics**

- CDMA (Rake receiver, interference cancellation)
- OFDM
- Multipath channels
- MIMO BLAST compare with Alamouti scheme

**Labs**: The laboratory works are software based and performed on PCs with MATLAB. Preparation is essential before each laboratory, and there will be an assessment for your preparation at the start of each lab, mainly to check whether you have prepared your programs for each lab and your understanding of the techniques which were taught in lectures. The Labs must be attended every second week starting from week 2. There are 5 labs to complete in total, and students must get marked by a demonstrator before the end of each lab session. Grades will be assigned according to the performance and progress in conducting of lab work and understanding of the related technical. A satisfactory performance in the lab component is a requirement of passing this course. This is related to learning outcomes 1, 2, 3, 4 and 5.

**Laboratory Experiments:**

<table>
<thead>
<tr>
<th>Lab No</th>
<th>Week</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2,3</td>
<td>Matlab warm up</td>
</tr>
<tr>
<td>1</td>
<td>4,5</td>
<td>Communication System Simulation</td>
</tr>
<tr>
<td>2</td>
<td>6,7</td>
<td>Wireless System simulation</td>
</tr>
</tbody>
</table>
Course Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>[1]</td>
</tr>
<tr>
<td>2</td>
<td>Wireless channel, path loss and shadowing</td>
<td>[1]</td>
</tr>
<tr>
<td>3</td>
<td>Multipath channel models</td>
<td>[1]</td>
</tr>
<tr>
<td>4</td>
<td>Digital modulation and Detection</td>
<td>[1]</td>
</tr>
<tr>
<td>5</td>
<td>Performance of digital modulation over wireless channels</td>
<td>[1]</td>
</tr>
<tr>
<td>6</td>
<td>Diversity</td>
<td>[1]</td>
</tr>
<tr>
<td>7</td>
<td>Space-time coding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Break</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td><strong>Mid-session examination, duration 2 hours</strong></td>
<td>[1]</td>
</tr>
<tr>
<td>9</td>
<td>Coding for wireless transmissions</td>
<td>[2]</td>
</tr>
<tr>
<td>10</td>
<td>Multicarrier modulation</td>
<td>[1]</td>
</tr>
<tr>
<td>11</td>
<td>Spread spectrum</td>
<td>[1]</td>
</tr>
<tr>
<td>12</td>
<td>MIMO systems</td>
<td>[2]</td>
</tr>
</tbody>
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Note: **Mid-session exam is scheduled for week 7, this time could be Modified due to the progress**

Resources

Textbooks

Prescribed textbook

The following textbook is prescribed for the course:


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:


**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 heath and safety, enrolment, rights, and general expectations of students, please refer to the School policies, see http://scoff.ee.unsw.edu.au/.

**Attendance**
Above 75%

**Special consideration:***
Following the university policy, but if attendance is below 75%, the lecturer in charge may not consider your application.