



THE UNIVERSITY OF
NEW SOUTH WALES

SCHOOL OF ELECTRICAL ENGINEERING
AND TELECOMMUNICATIONS

TELE4652

MOBILE AND SATELLITE COMMUNICATIONS

S2, 2009

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Course Details

Credits: The course is a 6 UoC; expected workload is 10-12 hours throughout the 12 in 13 week session.

Contact Hours: The course consists of 2 hours of lectures per week, one hour of tutorial per fortnight, and three hours of laboratories per fortnight:

Lecture Times: Wednesdays, 9-11am (MechEng 403)

Tutorials: Tuesday 1-2pm (Webst 138)
 Wednesday 5-6pm (Webst 138)

Laboratories: Mondays 12-3pm (EE322, Even and Odd week groups)
 Mondays 3-6pm (EE322, Odd weeks only)
 Wednesday 3-6pm (EE322, Even and Odd)

Note that it is likely that, if enrolment numbers are low, some of the tutorial and lab classes will be closed. These arrangements will be made and finalised in Week 1.

Lectures begin in Week 1, while Tutorials, and Laboratories will begin in Week 2.

Course information

Context and Aims: The aim of this course is to provide students with a systems level understanding of two of the most important digital telecommunication systems; Digital Cellular Mobile Communication Systems and Digital Satellite Communication Systems. It will demonstrate how digital modulation and channel coding techniques, as were taught in TELE4653 – Digital Modulation and Coding, and TELE4651 – Wireless Communications Technologies, are used to improve the reliability and performance of each system. It also aims to provide a general

understanding of these systems at a network perspective, with emphasis on system architecture and system design.

The syllabus covers Propagation-Loss models, mobile fading channels, multiple access techniques, the GSM and 3G standards, Digital Satellite Communication Systems, and equalisation and channel diversity techniques. Central to the course is a detailed explanation of the fundamentals of the existing digital mobile communication systems in Australia, as well as world-wide: GSM, CDMA IS-95, cdma2000 and 3G/UMTS. The emphasis of this course is less on the theoretical underpinnings of wireless communications, and more on how the conceptual building-blocks of wireless communication systems are implemented in real-world cellular and satellite communication systems.

Aims: At the successful completion of this course, it is expected that students:

- Understand the challenges of mobile communications and the engineering solutions that have been developed to create commercial cellular networks.
- Be able to explain the structure, design, and functionality of each of the major existing cellular networks: GSM, IS-95, and 3G networks.
- Have knowledge of the algorithms and circuits used in the implementation of the current cellular mobile and satellite communication systems.
- Have an appreciation of the latest developments and directions of research in modern cellular networks.
- Have a basic knowledge of satellite communications.

Relation to Other Courses

This course is a 4th year technical elective in the wireless communications discipline. It is aimed at students wishing to specialise in telecommunications in their degree, and possibly, their future careers.

Pre-requisites: Introductory courses in telecommunications (such as TELE3113: Analog and Digital Communication Systems at UNSW) and signal processing (ELEC3104: Digital Signal Processing) are necessary to undertake this course. A solid grounding in digital modulation and channel coding techniques, such as that gained in TELE4653, would be highly beneficial.

Assumed Knowledge: A basic knowledge and understanding of communication systems and the communication problem, as would be gained from TELE3113, is assumed. Basic knowledge of Fourier theory, digital filters and signal processing is also assumed. Above average competency in the fields of algebra, analysis, and statistics, gained from the second year core mathematics course, commensurate with a student wishing to specialise in telecommunications, will also be required.

The assignments and tutorials will require students to be familiar with MATLAB, or some other equivalent numerical computing platform. The laboratories are to be performed in EE332, the mobile communications laboratory. These laboratory tasks are quite challenging, performed on sophisticated hardware, and as such require students to have good experimental skills and preparation, as is expected by fourth year electrical engineering students.

Following Courses: As a final year technical elective, it is planned that the standard reached by students at the end of this course would be commensurate with that expected of a graduating telecommunications engineer. As a course focussing on real-world, practical systems and engineering solutions, it is hoped that this course will bring together many of the ideas taught in earlier courses, and allow students to understand how the concepts they have learnt at a more theoretical level are applied in actual existing communication systems, used in their everyday lives.

Learning Outcomes

At the end of the course the student should:

- (a) Be able to explain the network level structure and functionality of common mobile and satellite communication systems.

- (b) Explain and describe the practical implementation of the signal processing of the physical layer of the afore mentioned communication systems.
- (c) Identify the factors that determine the capacity of mobile cellular and satellite communication systems.
- (d) Be aware of modern trends in research and development of communication systems.

In this regard, this course will contribute to the attainment of the following UNSW graduate attributes:

- *the skills involved in scholarly enquiry*, through the self-directed completion of real-world communication problems in assignments and laboratories
- *an in-depth engagement with the relevant disciplinary knowledge in its interdisciplinary context*, as this is the pinnacle of the technical study of communication systems in the degree, whose thorough treatment necessitates the mutual exchange of concepts with other disciplines
- *the capacity for analytical and critical thinking and for creative problem-solving*, through the problem based learning approach adopted in the lectures, tutorials, laboratories, and assignments.

Syllabus

A general run-down of the topics covered in this course is as follows: Modern communication systems from a systems point of view. Cellular mobile communication systems. Radio Propagation-loss model. The mobile fading channel. Multiple access techniques: FDMA, TDMA, CDMA. Modulation and coding in mobile communication systems. Equalization and channel diversity. Wireless Standards – GSM, CDMA IS-95, cdma2000, and 3G WCDMA. Satellite Communication. Link-budget Analysis.

Teaching Strategies

The material of this course will be presented through a combination of lectures, tutorials, laboratories, and assignments.

Lectures: The lectures will focus on the theoretical analysis of cellular and satellite communication systems, along with a detailed description of existing networks and standards. The fundamental principles and specific network implementations will be illustrated with examples and simulations. Attendance at the lectures is compulsory, and moreover students are expected to prepare for the lecture in advance, as the formal notes will be available prior to each lecture. The lecture slides will take a different perspective from these written notes, and both these constitute examinable material.

Important announcements regarding the course, such as rescheduled classes due to public holidays, assignment submission dates, details of the final examination, will be made during the lectures. Students who miss lectures and so miss these announcements do so at their own risk – it is the obligation of the student to ensure they obtain the necessary information, and it is not the obligation of the lecturer to inform each student personally of any course developments.

Attendance will regularly be taken in the lectures and the tutorials. This attendance will carry no marks, however it will assist the lecturer assessing special consideration requests and supplementary exam requests at the end of session.

Tutorials: The tutorials aim to provide students with practical quantitative analysis of communication systems. The tutorials will take students through the important topics in the course, and aim to develop analytical and problem solving skills.

Tutorials will begin in week 2. It is compulsory that students attend a tutorial every second week. However, there is sufficient material, in the form of both questions and topics, so that each tutorial will cover slightly different questions every week, so students may wish to attend tutorials every week, particularly if they are struggling with a certain concept.

Laboratories: Students must attend the laboratory every fortnight at their allotted time. If students find they must miss a lab session for any reason (illness, family or work commitments), they are required to contact the lecturer and make alternative arrangements PRIOR TO the lab session in question. Students who have not done so will receive a mark of 0 for the missed lab session – there will be no exceptions. Some lab periods may need to be rescheduled due to public holidays, and the announcement of alternative arrangements will be made during the lectures. Students should view the access to these labs as a great privilege, and take them very seriously.

A satisfactory performance (70% or above) in the lab component is a requirement to passing this course. Students must be marked off by a lab demonstrator at the end of each lab session and have their mark recorded by the demonstrator. It is the responsibility of the student to make sure this is done. If no mark is recorded at the end of the lab for whatever reason, a mark of 0 will be given – once again, there will be no exceptions.

Students are required to maintain a laboratory journal, and the marks obtained directly correspond to the quality of this journal. The journal should record all equipment settings and connections, as well as any measurements and observations made. It is important for all engineers to accurately document all experimental work, and emphasis is placed on the lab journal in this course to ensure that students develop this important attribute of a professional engineer. The journal must be handed in for assessment at the end of the laboratory program.

There are 6 experiments to complete in total. All experiments will be performed in the Mobile Communication Lab in EE322, unless otherwise advised. The lab sheets will be made available on the course website prior to each lab. In the first week, once enrolment numbers are finalised, the exact schedule of the lab program will be determined.

At the beginning of each lab session there will be a small quiz that will be performed on Vista (beginning in the first lab, in Week 2 or 3). The quiz will consist of 8 multiple choice questions, from topics covered in the most recent lectures and tutorials. These quizzes will only be available at the beginning of the lab period. Students who are late and miss the quiz for any reason will receive an automatic mark of 0 for that quiz – there will be no exceptions. Students who miss a lab for any reason will not be able to catch on these quizzes.

Assignments: There will be two assignments, due in approximately Weeks 8 and 13. These assignments will largely involve students implementing and simulating communication systems in MATLAB. Reasonable competency in programming is thus assumed, and students who for some reason lack this competency are expected to be able to find the necessary assistance themselves and on their own time.

The assignments are compulsory and form an important assessment component of this course. Late assignments will suffer a late penalty of 10% reduction in the maximum attainable mark per day late, including weekends, with the submission date taken from the time when the assignment physically reaches the lecturer's hand. The assignments are to be submitted to the lecturer at the beginning of the lecture, and not put in the assignment box. Each assignment must have the appropriate assignment coversheet, properly filed out.

Assessment

There are four components of assessment in this course:

Final Examination:	55%
Labs:	20% (6 labs plus lab journal)
Assignments:	20% (Due weeks 8 and 13, approximately)
Lab Quizzes:	5% (online quizzes at the beginning of lab classes)

Final Examination: The exam in this course is a standard closed-book 3 hour examination, managed centrally by the exam unit. The examination will test analytical and critical thinking and the general understanding of the course material. Equal weight will be given to course topics in regard to the proportion of marks available. More details will be discussed during lectures, and past exam papers will be made available on the course website.

Laboratory Work: As discussed above, marks here will be awarded at the end of each fortnightly lab session based on the quality of each student's lab journal. A satisfactory performance in the lab (at least 70%) is necessary to pass this course. This requirement reflects the importance of every graduating engineer to be able to understand practical experimental issues. In addition, the lab journal must be handed in at the end of the laboratory program for final assessment.

Assignments: The two assignments will together account for 20% of a student's final grade. These assignments will be primarily MATLAB programming and simulations. Marks will be awarded based on the quality of a student's programming, their understanding and interpretation of the simulation results, and the competency of any analytical solutions.

Lab Quizzes: The six multiple choice quizzes conducted on Vista (vista.elearning.unsw.edu.au) will together make up 5% of the final grade in this course. The final grade will consist of the best five quiz marks for each student, meaning every student can drop their lowest quiz mark. Each quiz will consist of 8 multiple-choice questions and will be closed book. The motivation of these quizzes is to encourage students to keep up to date with the course material and concepts, and as such has a relatively small weight in the final grade.

Resources for students

Lecture Notes: A comprehensive set of typed lecture notes will be handed out at each lecture. These typed lecture notes will take the role of the textbook, since no available textbook quite covers all the course material at the depth required of this course. These lecture notes are the reference of examinable material – they effectively play the role of the detailed course syllabus.

In addition, the lecturer will make available the set of slides/overheads used in each lecture on the course website, for additional reference. The material in these slides will differ from the printed notes, in presentation, depth, and order of coverage, adjusted for effective presentation and communication. This material is examinable as well.

Textbooks: No available textbook covers all course topics; however several textbooks would still be extremely useful to students for reference:

Recommended Texts: (one of the following)

- W. Stallings, "Wireless Communications and Networks, 2nd Ed."; Pearson Prentice Hall, 2005.
- T.S. Rappaport, "Wireless Communications, Principles and Practice"; Prentice Hall, 1996/2002.
- B.A. Black, P.S. DiPiazza, B.A. Ferguson, D.R. Voltmer, and F.C. Berry, "Introduction to Wireless Systems"; Pearson Prentice Hall, 2008.

Reference Books: The following list of books will provide reference for various parts of the course, and can be found at the library as required:

- J. Proakis & M. Salehi, "Communication Systems Engineering", Prentice-Hall, 2nd Edition, 2002.
- S. Haykin, "Communication Systems", Wiley, 4th Edition, 2001.
- B. Lathi, "Modern Digital and Analog Communication systems", Holt Saunders, (most recent edition).
- L.W. Couch II, "Digital and Analog Communication Systems", Prentice-Hall, 5th Edition, 1997.

- M. Mouly and M-B. Pautet, "The GSM System for Mobile Communications." Telecomm Publishing, 1992.
- J. Eberspaecher, H-J. Voegel, and C. Bettstetter, "GSM Switching, Services, and Protocols", John Wiley and Sons, 2001.
- A.J. Viterbi, "CDMA – Principles of Spread Spectrum Communication", Addison Wesley, 1995.
- R.G. Gallager, "Principles of Digital Communication", Cambridge University Press, 2008.
- A. Goldsmith, "Wireless Communications"; Cambridge University Press, 2008.
- M. Schwartz, "Mobile Wireless Communications"; Cambridge University Press, 2008.
- T. Pratt, C.W. Bostian, and J.E. Allnuty, John Wiley & Sons, 2002.
- N. Benvenuto, R. Corvaja, T. Erseghe, & N. Laurenti, "Communication Systems", Wiley, 2007.
- V.K. Garg, "IS-95 CDMA and cdma2000: Cellular/PCS System Implementation" Prentice Hall, 2000.

Course Website:

Course Webpage: <http://subjects.ee.unsw.edu.au/tele4652>

Lecture Notes, tutorial solutions, assignments, and past exam papers can be downloaded from the course webpage.

Vista: <http://vista.elearning.unsw.edu.au>

WebCT Vista will be used for the on-line quizzes at the beginning of the laboratory sessions, and also for the release of assignment marks.

Other Matters

Academic honesty and plagiarism

Plagiarism is a serious issue at UNSW. Students should all be familiar with the university wide policy for plagiarism and academic honesty. This can be found at www.lc.unsw.edu.au/plagiarism.

Continual Course Improvement

Students are advised that 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 lecturer or via the CATEI course evaluation. Your comments and feedback are always greatly appreciated and highly valued.

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: <http://scoff.ee.unsw.edu.au>

Course Schedule (tentative)

Week	Topic	Tasks
1	Introduction to Cellular Concepts, AMPS, Trunking theory and network capacity.	
2	GSM (digital) cellular architecture. System levels operation of 2G networks.	Lab 1 (Quiz 1)
3	OSI and Protocol stacks in Mobile networks. GPRS and 2.5 G networks.	Lab 1 (Quiz 1)
4	RF circuits, E/M wave propagation, Antennae. Link-budget analysis	Lab 2 (Quiz 2)
5	Wireless channel models (macro-cell propagation-loss models and fading models)	Lab 2 (Quiz 2)
6	Multiple Access Techniques, CDMA and Spread Spectrum systems.	Lab 3 (Quiz 3)
7	Digital Communications I – modulation and coding	Lab 3 (Quiz 3)
8	Digital Communications II – equalisation and diversity.	Lab 4 (Quiz 4) Assignment 1 (Cellular Network Level Design)
9	The GSM standard	Lab 4 (Quiz 4)
10	IS-95 CDMA and cdma2000	Lab 5 (Quiz 5)
11	3G networks	Lab 5 (Quiz 5)
12	Satellite Communications	Lab 6 (Quiz 6)
13	No lecture (revision tutorial)	Lab 6 (Quiz 6) Assignment 2 (Physical Layer Design)