UNSW Course Outline

TELE9753 Advanced Wireless Communications - 2024

Published on the 08 Feb 2024

General Course Information

Course Code : TELE9753
Year : 2024
Term : Term 1
Teaching Period : T1
Is a multi-term course? : No
Faculty : Faculty of Engineering
Academic Unit : School of Electrical Engineering & Telecommunications
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Postgraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

Wireless communication technologies define how to efficiently, reliably, and securely transmit and receive information via electromagnetic waves over the air without wires, cables, or any other electrical conductors. In this modern and digital era, wireless communications have

become an integral part of daily life for everyone, including GPS, Wi-Fi, digital TV, wireless payment, cellular mobile phones (4G and 5G), Internet of Things (IoT), and Bluetooth. It is growing to be more important in the digital society as it facilitates easy information sharing and allows freedom to roam around the globe.

TELE9753 is a postgraduate course in Telecommunication Engineering. It 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.

Course Aims

This is a postgraduate course in Telecommunication Engineering. It provides advanced knowledge of wideband wireless communication techniques to enable students to analyze and design advanced wireless communication systems.

At the end of the course, you should be able to:

- be familiar with various types of wireless fading channel models and the effects of fading on the communication systems performance.
- have developed an understanding of various diversity techniques and their applications for wideband systems.
- have developed an understanding of wideband transmission technologies and their interference mitigation mechanisms.
- have developed an understanding of MIMO and multi-user technologies for wireless communications.

Relationship to Other Courses

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Explain the principles, algorithms and technologies, including diversity, interference averaging, interference management, successive interference cancellation, superposition modulation, etc, used in the transmission of information in wireless mobile channels
CLO2 : Analyse and derive expressions for error performance and capacity for various transmission schemes covered in the lectures, such as space-time coding, MRC, OFDM, CDMA
CLO3 : Explain the operation of example algorithms covered in lectures, and discuss the effects of varying parameter values within these (water-filling, channel inversion, MMSE, ZF)
CLO4 : Apply the principles and technique to communication systems design or undertake further research (case study based on allocated power, spectrum and users, QoS)

Course Learning Outcomes	Assessment Item
CLO1 : Explain the principles, algorithms and technologies, including diversity, interference averaging, interference management, successive interference cancellation, superposition modulation, etc, used in the transmission of information in wireless mobile channels	• Mid-term Examination • Homework • Final Examination
CLO2 : Analyse and derive expressions for error performance and capacity for various transmission schemes covered in the lectures, such as space-time coding, MRC, OFDM, CDMA	• Mid-term Examination • Homework • Final Examination
CLO3 : Explain the operation of example algorithms covered in lectures, and discuss the effects of varying parameter values within these (water-filling, channel inversion, MMSE, ZF)	• Homework • Final Examination
CLO4 : Apply the principles and technique to communication systems design or undertake further research (case study based on allocated power, spectrum and users, QoS)	• Final Examination

Learning and Teaching Technologies

Moodle - Learning Management System

Learning and Teaching in this course

Teaching Strategies

Delivery Mode

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

The teaching in this course aims at establishing a good fundamental understanding of the areas covered using:

- Formal lectures, which provide you with a focus on the core analytical material in the course, together with qualitative, alternative explanations to aid your understanding;
- Tutorials, which allow for exercises in problem-solving and allow time for you to resolve problems in understanding lecture material.

Learning in this course

You are expected to attend all lectures, tutorials, and mid-semester exams in order to maximise learning. You must prepare well for your laboratory classes and your lab work will be assessed. In addition to the lecture notes/video, you should read relevant sections of the recommended text. Reading additional texts will further enhance your learning experience. Group learning is also encouraged. UNSW assumes that self-directed study of this kind is undertaken in addition to attending face-to-face classes throughout the course.

Tutorial classes

You should attempt all of your problem sheet questions in advance of attending the tutorial classes. The importance of adequate preparation prior to each tutorial cannot be overemphasized, as the effectiveness and usefulness of the tutorial depends to a large extent on this preparation. Group learning is encouraged. Solutions to these questions will be discussed during the tutorial class and the tutor will cover the more complex questions in the tutorial class. In addition, during the tutorial class, your tutor may provide 1-2 new questions that are not in your notes, for you to try in class. These questions and solutions may not be made available on the web, so it is worthwhile for you to attend your tutorial classes to gain maximum benefit from this course.

Other Professional Outcomes

Engineers Australia, Professional Engineer Stage 1 Competencies

The learning outcomes of this course contribute to your development of the following EA competencies:

	EA Stage 1 Competencies	Course Learning Outcomes (CLOs)
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals	1, 2, 4
PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing		1, 2, 3, 4
PE1.3 In-depth understanding of specialist bodies of knowledge		2
PE1.4 Discernment of knowledge development and research directions		
PE1.5 Knowledge of engineering design practice		1
PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice		
PE2: Engineering Application Ability	PE2.1 Application of established engineering methods to complex problem solving	1, 2, 3, 4
PE2.2 Fluent application of engineering techniques, tools and resources		
PE2.3 Application of systematic engineering synthesis and design processes		4
PE2.4 Application of systematic approaches to the conduct and management of engineering projects		
PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability	
PE3.2 Effective oral and written communication (professional and lay domains)		
PE3.3 Creative, innovative and pro-active demeanour		
PE3.4 Professional use and management of information		
PE3.5 Orderly management of self, and professional conduct		
PE3.6 Effective team membership and team leadership		

Additional Course Information

Assumed Knowledge

- Be familiar with digital communications including fading channels, modulation, signal detection, etc.
- Some knowledge of programming languages such as MATLAB or C.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Mid-term Examination Assessment Format: Individual	35%	Due Date: TBC between 18 March - 24 March
Homework Assessment Format: Individual	15%	Due Date: Weekly homework submitted before next lecture
Final Examination Assessment Format: Individual	50%	

Assessment Details

Mid-term Examination

Assessment Overview

The mid-term examination tests your general understanding of the course material and is designed to give you feedback on your progress through the analytical components of the course. Questions may be drawn from any course material up to the end of week 5 or 6. It may contain questions requiring some (not extensive) knowledge of laboratory material, and will definitely contain numerical and analytical questions. Marks will be assigned according to the correctness of the responses.

Course Learning Outcomes

- CLO1 : Explain the principles, algorithms and technologies, including diversity, interference averaging, interference management, successive interference cancellation, superposition modulation, etc, used in the transmission of information in wireless mobile channels
- CLO2 : Analyse and derive expressions for error performance and capacity for various transmission schemes covered in the lectures, such as space-time coding, MRC, OFDM, CDMA

Assessment Length

about one hour to one and half hours

Homework

Assessment Overview

The homework tests your general understanding of the course materials. It will be given for some specific chapters. Grades will be assigned according to the understanding of each question/exercise. The lectures can only cover the course material to a certain depth; you must read the textbook(s) and reflect on its content in 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.

Course Learning Outcomes

- CLO1 : Explain the principles, algorithms and technologies, including diversity, interference averaging, interference management, successive interference cancellation, superposition modulation, etc, used in the transmission of information in wireless mobile channels
- CLO2 : Analyse and derive expressions for error performance and capacity for various transmission schemes covered in the lectures, such as space-time coding, MRC, OFDM, CDMA
- CLO3 : Explain the operation of example algorithms covered in lectures, and discuss the effects of varying parameter values within these (water-filling, channel inversion, MMSE, ZF)

Final Examination

Assessment Overview

The exam in this course is a standard closed-book 2 hour 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 (including laboratory) unless specifically indicated otherwise by the lecturer. Marks will be assigned according to the correctness of the responses.

Course Learning Outcomes

- CLO1 : Explain the principles, algorithms and technologies, including diversity, interference averaging, interference management, successive interference cancellation, superposition modulation, etc, used in the transmission of information in wireless mobile channels
- CLO2 : Analyse and derive expressions for error performance and capacity for various transmission schemes covered in the lectures, such as space-time coding, MRC, OFDM, CDMA
- CLO3 : Explain the operation of example algorithms covered in lectures, and discuss the effects of varying parameter values within these (water-filling, channel inversion, MMSE, ZF)
- CLO4 : Apply the principles and technique to communication systems design or undertake further research (case study based on allocated power, spectrum and users, QoS)

General Assessment Information

Grading Basis

Standard

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 12 February - 18 February	Lecture	Introduction of wireless communications systems (Chapter 1) Cellular Mobile Systems WiFi Systems
Week 2 : 19 February - 25 February	Lecture	Wireless Channels (Chapter 2 pp. 10-42) Wireless Propagation, Channel fading, Large-scale fading and small-scale fading Channel Coherence time and channel coherence bandwidth Frequency selective and time selective channels
Week 3 : 26 February - 3 March	Lecture	Time Diversity and Receive Diversity (Chapter 3, pp. 49-70) Diversity concept, optimal combining, diversity gain, array gain, error performance analysis over fading channels Maximum-ratio combining, equal-gain combining, selection combining Receiver beamforming
Week 4 : 4 March - 10 March	Lecture	Transmit Diversity (S.M. Alamouti, "A simple transmit diversity technique for wireless communications". IEEE Journal on Selected Areas in Communications vol. 16, no. 8: pp. 1451 1458. Oct. 1998.; B. Vucetic and J. Yuan, Space-Time Coding, 2003) Transmit beamforming, Space-time codes, Alamouti scheme
Week 5 : 11 March - 17 March	Lecture	Frequency Diversity (Chapter 3 pp. 49-70 and pp. 496-504) OFDM, Multicarrier Modulation, Frequency-domain equaliser CDMA, Rake receiver
Week 6 : 18 March - 24 March	Assessment	Midterm Exam (TBC) Interference Management Revision (Chapter 4, pp.120-155) Multiple Access, frequency reuse, power control, cell/sector handoff, interference averaging
Week 7 : 25 March - 31 March	Lecture	Channel Capacity (Chapter 5, pp. 166-216) AWGN channel capacity, capacity for fading channels,
Week 8 : 1 April - 7 April	Lecture	Capacity for wireless channels (Chapter 5, pp. 166-216) Capacity with and without channel state information Outage capacity Water Filling
Week 9 : 8 April - 14 April	Lecture	Multiuser channels, Opportunistic Beamforming (chapter 6, pp. 228-270, Sec. 6.1, 6.2, 6.6, 6.7) Multiuser channels for uplink and downlinks Successive interference cancellation (SIC) and capacity region Multiuser Opportunistic Communication Multiuser Diversity Proportional fairness scheduling
Week 10 : 15 April - 21 April	Lecture	MIMO and multiuser systems (chapter 7, pp. 290-328) MIMO channels MIMO capacity with water filling and singular value decomposition Multiuser MIMO Angular resolution

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

Course Resources

Prescribed 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.

[2] Andrew Goldsmith, Wireless Communications, Cambridge University Press, 2005.

You may need 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:

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

Online resources

Moodle

As a part of the teaching component, Moodle will be used to disseminate teaching materials, host forums, and occasionally quizzes. Assessment marks will also be made available via Moodle: https://moodle.telt.unsw.edu.au/login/index.php.

Teams

As a part of the teaching component, Teams will be used as a teaching platform.

Mailing list

Announcements concerning course information will be given in the lectures and/or on Moodle and/or via email (which will be sent to your student email address).

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Jinhong Yuan		EE 408	93854244	4-5 pm before class	No	Yes
Lecturer	Min Qiu				4-5 pm before class	No	No
	Qingqing Cheng				4-5 pm before class	No	No

Other Useful Information

Academic Information

I. Special consideration and supplementary assessment

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to, or within 3 working days of, submitting an assessment or sitting an exam.

Please note that UNSW has a Fit to Sit rule, which means that if you sit an exam, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

II. Administrative matters and links

All students are expected to read and be familiar with UNSW guidelines and polices. In particular, students should be familiar with the following:

- Attendance
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Equitable Learning Services

III. Equity and diversity

Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equitable Learning Services. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

IV. Professional Outcomes and Program Design

Students are able to review the relevant professional outcomes and program designs for their streams by going to the following link: https://www.unsw.edu.au/engineering/student-life/student-resources/program-design.

Note: This course outline sets out the description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle or your primary learning management system (LMS) should be consulted for the up-to-date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline/Moodle/LMS, the description in the Course Outline/Moodle/LMS applies.

Academic Honesty and Plagarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism, visit: student.unsw.edu.au/plagiarism. The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis or contract cheating) even suspension from the university. The Student Misconduct Procedures are available here:

www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Submission of Assessment Tasks

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of five percent (5%) of the maximum mark possible for that assessment item, per calendar day.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day. This is for all assessments where a penalty applies.

Work submitted after five days (120 hours) will not be accepted and a mark of zero will be awarded for that assessment item.

For some assessment items, a late penalty may not be appropriate. These will be clearly indicated in the course outline, and such assessments will receive a mark of zero if not completed by the specified date. Examples include:

- Weekly online tests or laboratory work worth a small proportion of the subject mark;
- Exams, peer feedback and team evaluation surveys;
- Online quizzes where answers are released to students on completion;
- Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date; and,
- Pass/Fail assessment tasks.

Faculty-specific Information

Engineering Student Support Services – The Nucleus - enrolment, progression checks, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries e.g. admissions, fees, programs, credit transfer

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

School-specific Information

General Conduct and Behaviour

Consideration and respect for the needs of your fellow students and teaching staff is an expectation. Conduct which unduly disrupts or interferes with a class is not acceptable and students may be asked to leave the class.

Use of AI for assessments

Your work must be your own. If you use AI in the writing of your assessment, you must acknowledge this and your submission must be substantially your own work. More information can be found on this website.

Workplace Health & Safety (WHS)

WHS for students and staff is of utmost priority. Most courses involve laboratory work. You must follow the rules about conduct in the laboratory. About COVID-19, advice can be found on this website.

School Contact Information

Consultations: Lecturer consultation times will be advised during the first lecture. You are welcome to email the tutor or laboratory demonstrator, who can answer your questions on this course and can also provide you with consultation times. ALL email enquiries should be made from your student email address with ELEC/TELExxxx in the subject line; otherwise they will not

be answered.

Keeping Informed: Announcements may be made during classes, via email (to your student email address) and/or via online learning and teaching platforms – in this course, we will use Moodle https://moodle.telt.unsw.edu.au/login/index.php. Please note that you will be deemed to have received this information, so you should take careful note of all announcements.

Student Support Enquiries

For enrolment and progression enquiries please contact Student Services

Web

Electrical Engineering Homepage