

# TELE9754

Coding and Information Theory

Term 3, 2021



## Course Overview

### Staff Contact Details

#### Convenors

Name	Email	Availability	Location	Phone
Wei Zhang	<a href="mailto:w.zhang@unsw.edu.au">w.zhang@unsw.edu.au</a>	office hours	Elec Eng Building 416	93854033

### 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](#)

[Engineering Student Support Services](#)

[Engineering Industrial Training](#)

[UNSW Study Abroad and Exchange](#) (for inbound students)

[UNSW Future Students](#)

## 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)

## Email

[Engineering Student Support Services](#) – current student enquiries

- e.g. enrolment, progression, 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

## Course Details

### Units of Credit 6

### Summary of the Course

The course provides advanced knowledge of coding and information theory widely applied in modern wireless systems. It includes the classical information theory (entropy, mutual information, channel coding theorem and channel capacity), channel coding techniques, MIMO theory (MIMO capacity, space-time coding), OFDM technique (transmitter/receiver design), Massive MIMO, 5G systems & applications.

### Course Aims

The course aims to make students familiar with the advanced knowledge of coding and information theory used in the modern wireless systems and applications, and to enable them to work on relevant projects in wireless systems with some research skills.

### Course Learning Outcomes

After successfully completing this course, you should be able to:

Learning Outcome	EA Stage 1 Competencies
1. Understand the fundamentals of information theory and channel capacity	PE1.2
2. Understand and explain the principles of coding techniques used in digital communication systems	PE1.3
3. Recognize advances of coding theory in next generation broadband communication systems	PE1.4
4. Perform independent work in wireless system design with some creative problem-solving ability	PE2.1
5. Effectively communicate through presentations, technical writing and research discussion	PE3.2
6. Appreciate the benefits of teamwork through collaboration with other professionals	PE3.6

### Teaching Strategies

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

- Lectures, which provide you with a focus on the core analytical material in the course, together with qualitative, alternative explanations to aid your understanding;

During the lecture, theories and other relevant information will be expounded by the lecturer. Core materials of the course will be elaborated with a variety of practical examples. As the course emphasizes

interactive learning, students are encouraged to ask questions and express feedback during the lectures.

## **Additional Course Information**

### **Relationship to Other Courses**

TELE9754 is a core course for postgraduate program in telecommunications. It is aimed at students wishing to specialise in telecommunications in their degree, and possibly, their future careers. TELE9754 is well complemented by TELE9753 Advanced Wireless Communications, which covers comprehensive knowledge of wideband wireless communication design techniques including diversity techniques, multiple access, antenna array, space-time processing, multiuser detection, opportunistic communications and interference management.

### **Pre-requisites:**

The minimum pre-requisite for TELE9754 is TELE3113, Analogue and Digital Communications. TELE4653 Digital Modulation and Coding is highly desirable.

### **Assumed Knowledge:**

- A good background of mathematics including probability theory.
- Some knowledge of programming language such as MATLAB or C.
- Be familiar with digital communications including fading channels, modulation, signal detection, etc.

### **Following Courses**

As a core course for postgraduate program in telecommunications, 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. There are no follow on courses as such, but students will find that the underlying principles of communication systems taught in this course will provide deeper insight into specialist communications courses in wireless communications, mobile and satellite communications, and optical fibre communications.

## Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Final Examination	60%	Not Applicable	1, 2, 4
2. Research Project	20%	25/11/2021 11:59 PM	1, 2, 3, 4, 5, 6
3. Research Presentation	10%	Not Applicable	2, 3, 5
4. Research Writing	10%	17/10/2021 11:59 PM	2, 3, 5

### Assessment 1: Final Examination

**Assessment length:** 2 hours

The exam in the course is a standard closed-book written examination, comprising not more than seven compulsory questions. The final examination will test students' understanding of the course material and analytical skills.

### Assessment 2: Research Project

**Due date:** 25/11/2021 11:59 PM

The project in this course requires students to solve some research problems by giving some analysis and performing computer (Matlab) simulation to validate the analysis. The project will test students the abilities of creative problem solving, independent critical thinking, and teamwork management.

Project details will be given in the end of October and students are required to submit project reports before/on **25 November 2021 (Due Time: 23:59)**. Students are encouraged to collaborate with the other student in one group (at most 2 students in one group). Note that the projects vary from different groups. As a penalty, student who is absent in any class without an appropriate excuse must do the project alone.

### Assessment 3: Research Presentation

The student will give an oral presentation (5~8 minutes, exact time allowed will be notified later) with PowerPoint. The research topic is not limited, but consulting course staff is preferred. The presentation will test the abilities of students in making effective communications and explaining advanced communications technologies.

### Assessment 4: Research Writing

**Due date:** 17/10/2021 11:59 PM

The student will choose a research topic by herself/himself within research scope of wireless communications, write a research report on the selected topic. The research topic is not limited, but consulting course staff is preferred. The writing will test the abilities of students in retrieving and evaluating literature information, engaging in a particular research topic, and writing a technical report.

## Attendance Requirements

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

## Course Schedule

Due to the COVID-19, the lectures will be delivered online on **Tuesday 18:00 - 21:00** (Weeks:1-10).

Please check Moodle for the online lecture details.

<https://moodle.telt.unsw.edu.au/course/view.php?id=62599>

<b>TELE9754 T3, 2021</b>	<b>Tuesday 6-9 pm</b>	<b>Topics</b>
<b>Week 1</b>	14 September	Review of Probability Theory
<b>Week 2</b>	21 September	Fundamentals of Information Theory
<b>Week 3</b>	28 September	Channel Capacity
<b>Week 4</b>	5 October	Gaussian Channel
<b>Week 5</b>	12 October	Channel Coding
<b>Week 6</b>	19 October	Research Workshop (Oral Presentation)
<b>Week 7</b>	26 October	Research Workshop (Oral Presentation)
<b>Week 8</b>	2 November	MIMO Theory
<b>Week 9</b>	9 November	Space-Time Coding
<b>Week 10</b>	16 November	MIMO-OFDM

## Resources

### Prescribed Resources

Reference book:

Thomas M. Cover and Joy A. Thomas, **Elements of Information Theory**, 2nd Ed., John Wiley & Sons, 2006.

Lecture Notes:

Please download them each week at <https://moodle.telt.unsw.edu.au/course/view.php?id=62599>

### Recommended Resources

- John G. Proakis, *Digital Communications*, 5th Ed., McGraw-Hill, 2007.
- Robert J. McEliece, *The Theory of Information and Coding*, 2nd Ed., Cambridge University Press, 2002.
- Erik G. Larsson and Petre Stoica, *Space-time Block Coding for Wireless Communications*, Cambridge University Press, 2003.

### Course Evaluation and Development

- Any feedback on the course to improve the quality of learning and teaching is appreciated. Please feel free to talk to your lecture staff about it.
- Students' feedback is gathered periodically on-class and such feedback will be considered carefully with a view to acting on it constructively wherever possible.
- The feedback is gathered using various means, including myExperience tool. <https://student.unsw.edu.au/myexperience>



## **Academic Honesty and Plagiarism**

### **Academic Honesty and Plagiarism**

Plagiarism is the unacknowledged use of other people's work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a form of academic misconduct, and the University has very strict rules that include some severe penalties. For UNSW policies, penalties and information to help you avoid plagiarism, see <https://student.unsw.edu.au/plagiarism>. To find out if you understand plagiarism correctly, try this short quiz: <https://student.unsw.edu.au/plagiarism-quiz>.

### **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.

## Academic Information

### COVID19 - Important Health Related Notice

Your health and the health of those in your class is critically important. You must stay at home if you are sick or have been advised to self-isolate by [NSW health](#) or government authorities. Current alerts and a list of hotspots can be found [here](#). **You will not be penalised for missing a face-to-face activity due to illness or a requirement to self-isolate.** We will work with you to ensure continuity of learning during your isolation and have plans in place for you to catch up on any content or learning activities you may miss. Where this might not be possible, an application for fee remission may be discussed.

If you are required to self-isolate and/or need emotional or financial support, please contact the [Nucleus: Student Hub](#). If you are unable to complete an assessment, or attend a class with an attendance or participation requirement, please let your teacher know and apply for [special consideration](#) through the [Special Consideration portal](#). To advise the University of a positive COVID-19 test result or if you suspect you have COVID-19 and are being tested, please fill in this [form](#).

UNSW requires all staff and students to follow NSW Health advice. Any failure to act in accordance with that advice may amount to a breach of the Student Code of Conduct. Please refer to the [Safe Return to Campus](#) guide for students for more information on safe practices.

### Dates to note

Important Dates available at: <https://student.unsw.edu.au/dates>

## Student Responsibilities and Conduct

Students are expected to be familiar with and adhere to all UNSW policies (see <https://student.unsw.edu.au/policy>), and particular attention is drawn to the following:

### Workload

It is expected that you will spend at least **15 hours per week** studying a 6 UoC course, from Week 1 until the final assessment, including both formal classes and *independent, self-directed study*. In periods where you need to complete assignments or prepare for examinations, the workload may be greater. Over-commitment has been a common source of failure for many students. You should take the required workload into account when planning how to balance study with employment and other activities.

### Attendance

Regular and punctual attendance at all classes is expected. UNSW regulations state that if students attend less than 80% of scheduled classes they may be refused final assessment.

### Work Health and Safety

UNSW policy requires each person to work safely and responsibly, in order to avoid personal injury and to protect the safety of others.

## Special Consideration and Supplementary Examinations

You must submit all assignments and attend all examinations scheduled for your course. You can apply for special consideration when illness or other circumstances beyond your control interfere with an assessment performance. If you need to submit an application for special consideration for an exam or assessment, you must submit the application **prior to the start** of the exam or before the assessment is submitted, except where illness or misadventure prevent you from doing so. Be aware of the “fit to sit/submit” rule which means that if you sit an exam or submit an assignment, you are declaring yourself well enough to do so and cannot later apply for Special Consideration. For more information and how to apply, see <https://student.unsw.edu.au/special-consideration>.

## 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 and UNSW policies:

<https://student.unsw.edu.au/guide>

<https://www.engineering.unsw.edu.au/electrical-engineering/resources>

## Image Credit

Synergies in Sound 2016

## CRICOS

CRICOS Provider Code: 00098G

## Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

## Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	✓
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	✓
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	✓
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering problem solving	✓
PE2.2 Fluent application of engineering techniques, tools and resources	
PE2.3 Application of systematic engineering synthesis and design processes	
PE2.4 Application of systematic approaches to the conduct and management of engineering projects	
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	
PE3.2 Effective oral and written communication in 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	✓