School of Electrical Engineering & Telecommunications

UNSW Engineering

TELE4653

Digital Modulation and Coding

Term 1, 2023

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Wei Zhang	w.zhang@unsw.edu.au			

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

TELE4653 introduces the fundamental concepts in both digital modulation and coding. It comprises fundamentals of communications concepts (signal space, random variables, random process), digital modulation and demodulation techniques (M-ary ASK, QPSK, FSK, CPM, spectral analysis of modulated signals, ML and MAP detectors), performance analysis, synchronization techniques, coding theory (block codes and convolutional codes), and multi-carrier modulation and coding.

Course Aims

The course aims to assist students to be familiar with fundamentals of telecommunications, develop understanding of digital modulation and coding theory, and deduce and analyse the behaviour of a telecommunication system.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Be familiar with all the key elements of a digital communication system and at a theoretical level can identify and quantify the factors that determine the performance of a digital communication system	PE1.1, PE1.2, PE1.3, PE1.4, PE1.5, PE2.1, PE2.2, PE3.2, PE3.3
2. Be familiar with major modulation techniques, their practical considerations, and be capable of quantifying the performance of a generic modulation scheme	PE1.1, PE1.2, PE1.3, PE1.5, PE2.2, PE3.3
3. Understand the importance and rationale of channel coding in communication, and implement and analyse block coding and convolutional coding schemes	PE1.1, PE1.2, PE2.2

Teaching Strategies

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 of digital modulation and coding. As the course emphasizes interactive learning, students are encouraged to ask questions and express feedback during the lectures.

The tutorial provides students in-depth quantitative understanding of digital modulation/demodulation and coding techniques. Students will practise their problem-solving skills in the form of discussion and class exercises.

The laboratory work offers students hands-on experience in generating and detecting wireless data signals in various modulation formats, and thus helps students understand the core materials of the

course.

Additional Course Information

Course Moodle page:

https://moodle.telt.unsw.edu.au/course/view.php?id=72817

Relationship to Other Courses

TELE4653 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:** TELE3113: Analogue and Digital Communications, or equivalent, is required. It is also desirable that students have completed ELEC3104: Digital Signal Processing, as several of the ideas taught in that course lay the foundation in some areas of this subject. In addition, a substantial level of mathematics and statistics is required to adequately master the subject matter.

- **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 on-site laboratories are to be performed on TIMS, the signal processing platform extensively used in TELE3113 and ELEC3104.

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. 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, 3
2. Laboratory Work	20%	Not Applicable	1, 2, 3
3. Assignments	20%	Not Applicable	1, 2, 3

Assessment 1: Final Examination

Assessment length: 2 hours

The final examination is a standard closed-book 2-hour written examination, held after week 10, comprising not more than 7 compulsory questions. The final examination will test students' understanding of the course material and analytical skills. Assessment is a graded mark according the correct fraction of the answers to the exam questions.

Assessment 2: Laboratory Work

There are 4 laboratory experiments to complete.

【Online labs for students outside Australia only】Students must complete the online labs available at Moodle course website every fortnight and submit the lab reports by the due time. For more details, please refer to online lab section at Moodle course website.

【On-campus labs】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. Students who have not done so will receive a mark of zero for the missed lab session – there will be no exceptions. Students must be marked off by a lab demonstrator at the end of each lab session and have their mark recorded by the demonstrator. If no mark is recorded at the end of the lab for whatever reason, a mark of zero will be given. 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.

Assessment 3: Assignments

There are TWO assignments to complete. The details of the assignments will be made available on the course website in Week 5 and Week 10, respectively. The assignments are to be submitted to the lecturer's email (w.zhang@unsw.edu.au) in PDF file with an email subject "TELE4653 Assignment - student ID & name". Students must submit the assignment on or before the due date.

Attendance Requirements

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

Course Schedule

Class Timetable

https://timetable.unsw.edu.au/2023/TELE4653.html

Please check Moodle for the details of the remote access.
https://moodle.telt.unsw.edu.au/course/view.php?id=72817

Lecture Schedule:

TELE4653 **Term 1, 2023**	**Monday 4pm - 6pm** **Law Theatre G02 (K-F8-G02)**	**Topics**	**Reference** **[1]**
Week 1	13 February	Fundamentals	Chapter 2
Week 2	20 February	Modulation	Chapter 3
Week 3	27 February	Modulation	Chapter 3
Week 4	6 March	Synchronization	Chapter 5
Week 5	13 March	Channel Coding	Chapter 7-8
Week 6 flexibility week	20 March		
Week 7	27 March	Detection	Chapter 4
Week 8	3 April	Detection	Chapter 4
Week 9	10 April (public holiday)		
Week 10	17 April	Detection	Chapter 4

Tutorials will be delivered in hybrid mode on every Friday **from Week 2** at Tyree Energy Technology LG05 (K-H6-LG05).

Labs will be conducted on-site or online (for students outside Australia). The four different labs are scheduled in Weeks 3-10.

Labs **on-site**	Weeks 3-10	See timetable	Location: EE219
Labs **on-line**	Weeks 3, 5, 7, 9	anytime	Moodle page

Resources

Prescribed Resources

Prescribed textbooks

1. John G. Proakis and Masoud Salehi, Digital Communications, 5th Ed., McGraw-Hill, 2008.

Recommended Resources

Reference books

2. Simon Haykin, Communication Systems, 4th Ed., John Wiley & Sons, 2000.

3. Nevio Benvenuto, Roberto Corvaja, Tomaso Erseghe, and Nicola Laurenti, Communication Systems: Fundamentals and Design methods, John Wiley & Sons, 2006.

4. Simon Haykin and Michael Moher, Introduction to Analog & Digital Communications, 2nd Ed, John Wiley & Sons, 2006.

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

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 or email 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.

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. **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.unsw.edu.au/engineering/our-schools/electrical-engineering-telecommunications/student-life/resources

Disclaimer

This Course Outline sets out 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 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 (as updated in Moodle), the description in the Course Outline/Moodle applies.

Image Credit

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CRICOS

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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	