UNSW Course Outline

TELE4653 Digital Modulation and Coding - 2024

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General Course Information

Course Code : TELE4653
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, Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

This course aims at students wishing to specialise in telecommunications in their degree. Modulation and Coding are two essential components of all modern digital communication systems, e.g., radio, TV, satellite, computer, cellular phones, and 3G/4G/5G systems. These two

together allow for high-speed, error-free transmission over a wireless channel which is prone to noise, fading, and interference.

The course contents include:

- Communication concepts: Fourier transforms, random signals, transmitter and receiver filters, matched filter, Nyquist criterion.
- Digital Modulation schemes: M-ary ASK, QPSK, FSK, CPM, spectral analysis of modulated signals, ML and MAP detectors, signal space methods, bit error rate analysis.
- Digital Receivers: carrier and clock synchronisation.
- Information theory: entropy, channel capacity, source coding.
- Channel Coding: block codes, convolutional codes.

Course Aims

This course provides engineering knowledge in the wireless communications discipline. At the end of the course, you should be able to:

- Understand the fundamental knowledge of communication systems,
- Develop an understanding of digital modulation and coding used in modern communication systems
- Explain and analyze the performance of communication systems with different coding and modulation schemes.

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.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Recognise all the key elements of a digital communication system and identify and quantify the factors that determine the performance of a digital communication system
CLO2 : Explain major modulation techniques, their practical considerations, and quantify the performance of a generic modulation scheme
CLO3 : Recognise the importance and rationale of channel coding in communication, and implement and analyse block coding and convolutional coding schemes

Course Learning Outcomes	Assessment Item
CLO1 : Recognise all the key elements of a digital communication system and identify and quantify the factors that determine the performance of a digital communication system	• Final Exam • Assignment 1 • Assignment 2
CLO2 : Explain major modulation techniques, their practical considerations, and quantify the performance of a generic modulation scheme	• Laboratory Work • Final Exam • Assignment 1
CLO3 : Recognise the importance and rationale of channel coding in communication, and implement and analyse block coding and convolutional coding schemes	• Laboratory Work • Assignment 2 • Final Exam

Learning and Teaching Technologies

Moodle - Learning Management System | Echo 360

Other Professional Outcomes

Engineers Australia, Professional Engineer Stage 1 Competencies

The course learning outcomes (CLOs) contribute to your development of EA competencies:

PE1: Knowledge and Skill Base

- PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals: CLOs 1, 2,

3

- PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing: CLOs 1, 2, 3
- PE1.3 In-depth understanding of specialist bodies of knowledge: CLOs 1, 2, 3
- PE1.4 Discernment of knowledge development and research directions: CLO 2,3
- PE1.5 Knowledge of engineering design practice: CLOs 3
- 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: CLOs 2, 3
- PE2.2 Fluent application of engineering techniques, tools and resources: CLOs 2,3
- PE2.3 Application of systematic engineering synthesis and design processes:
- 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): CLOs 2, 3
- PE3.3 Creative, innovative and pro-active demeanour
- PE3.4 Professional use and management of information: CLOs 1, 2, 3
- PE3.5 Orderly management of self, and professional conduct:
- PE3.6 Effective team membership and team leadership:

Additional Course Information

Course Moodle page:

https://moodle.telt.unsw.edu.au/course/view.php?id=81752

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Final Exam Assessment Format: Individual	60%	
Laboratory Work Assessment Format: Individual	20%	
Assignment 1 Assessment Format: Individual	10%	
Assignment 2 Assessment Format: Individual	10%	

Assessment Details

Final Exam

Assessment Overview

The final examination at the end of the term is a standard closed-book 2-hour written examination, comprising not more than 7 compulsory questions. Questions may be drawn from any aspect of the course unless specifically indicated otherwise by the lecturer. The examination will test students' understanding of the course material and analytical skills. Assessment is a graded mark according to the correct fraction of the answers to the exam questions.

Course Learning Outcomes

- CLO1 : Recognise all the key elements of a digital communication system and identify and quantify the factors that determine the performance of a digital communication system
- CLO2 : Explain major modulation techniques, their practical considerations, and quantify the performance of a generic modulation scheme
- CLO3 : Recognise the importance and rationale of channel coding in communication, and implement and analyse block coding and convolutional coding schemes

Laboratory Work

Assessment Overview

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 marks 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.

Course Learning Outcomes

- CLO2 : Explain major modulation techniques, their practical considerations, and quantify the performance of a generic modulation scheme
- CLO3 : Recognise the importance and rationale of channel coding in communication, and implement and analyse block coding and convolutional coding schemes

Assignment 1

Assessment Overview

Assignment 1 relates to topics covered in the first half of the term (Modulation and Synchronisation). The details will be made available on the course website in Week 5. Your written report will be marked against the assessment criteria.

Course Learning Outcomes

- CLO1 : Recognise all the key elements of a digital communication system and identify and quantify the factors that determine the performance of a digital communication system
- CLO2 : Explain major modulation techniques, their practical considerations, and quantify the performance of a generic modulation scheme

Assignment 2

Assessment Overview

Assignment 2 relates to topics covered in the second half of the term (Coding and Detection, etc.). The details will be made available on the course website in Week 10. Your written report will be marked against the assessment criteria.

Course Learning Outcomes

- CLO1 : Recognise all the key elements of a digital communication system and identify and quantify the factors that determine the performance of a digital communication system
- CLO3 : Recognise the importance and rationale of channel coding in communication, and implement and analyse block coding and convolutional coding schemes

General Assessment Information

Grading Basis

Standard

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 12 February - 18 February	Lecture	Topic: Fundamentals Chapter 2 of [1]
Week 2 : 19 February - 25 February	Lecture	Topic: Digital Modulation Chapter 3 of [1]
Week 3 : 26 February - 3 March	Lecture	Topic: Digital Modulation Chapter 3 of [1]
Week 4 : 4 March - 10 March	Lecture	Topic: Synchronisation Chapter 5 of [1]
Week 5 : 11 March - 17 March	Lecture	Topic: Channel Coding Chapters 7 and 8 of [1]
Week 6 : 18 March - 24 March	Lecture	There are no lectures this week.
Week 7 : 25 March - 31 March	Lecture	Topic: Optimum Receivers for AWGN Channels Chapter 4 of [1]
Week 8 : 1 April - 7 April	Lecture	Topic: Signal Demodulation Chapter 4 of [1]
Week 9 : 8 April - 14 April	Lecture	Topic: Signal Demodulation Chapter 4 of [1]
Week 10 : 15 April - 21 April	Lecture	Topic: An Introduction to Information Theory Chapter 6 of [1]

Attendance Requirements

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

General Schedule Information

Class Timetable

https://timetable.unsw.edu.au/2024/TELE4653.html

Please check Moodle frequently for the lecture notes and news.
https://moodle.telt.unsw.edu.au/course/view.php?id=81752

Lectures will run from Week 1 to Week 10 except Week 6 (Flexibility week).

Tutorials will be delivered on every Wednesday from **Week 2** at **Old Main Building 150**.

Labs will be conducted on-site. The four different labs are scheduled in Weeks 3-10.
Lab 1 - Week 3 and Week 4
Lab 2 - Week 5 and Week 6
Lab 3 - Week 7 and Week 8
Lab 4 - Week 9 and Week 10

Course 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 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

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Wei Zhang					No	Yes

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