School of Electrical Engineering and Telecommunications

Term 2, 2020
Course Outline

TELE3113
Analogue and Digital Communications

COURSE STAFF

Course Convener, Lecturer and Tutor: Dr. Gayathri Kongara g.kongara@unsw.edu.au
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Consultations: Lectures are delivered online and are designed to be interactive sessions. You are encouraged to ask questions on the course material, during and after the lecture class times in the first instance, rather than via email. It is important that you use Moodle discussion forum to ask questions on the course material. Lecturer consultation times will be advised during lectures, and further consultations can be made by appointment by email. Note that, due to the lecturer's full-time commitments in industry, consultations will not be possible outside of class times without an appointment. You are welcome to email the course convenor who can answer your questions on this course by email. ALL email enquiries should be made from your student email address with TELE3113 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.

COURSE SUMMARY

Contact Hours

The course consists of 4 hours of lectures, a 1-hour tutorial, and a 3-hour laboratory session per week (see laboratory schedule). The lectures begin in Week 1, the Tutorials in Week 2, and the Labs in Week 2.

Lectures	Day	Time	Location
	Monday (Weeks 1 to 4, 6 to 10	4pm – 6pm	Blackboard collaborate Link on Moodle
	Thursday (Weeks 1 to 10)	4pm – 6pm	Blackboard collaborate Link on Moodle
	Monday (Week 11)	4pm – 6pm	Blackboard collaborate Link on Moodle
			Blackboard collaborate Link on Moodle
Tutorials	Tuesday	1pm - 2pm	Blackboard collaborate Link on Moodle
Labs	Monday to Friday	Check Your Timetable	Blackboard collaborate Link on Moodle
Mid-Term	29th June 2020, Monday	4pm - 6pm	Blackboard collaborate Link on Moodle

Context and Aims

TELE3113 is a main and pre-requisite course in telecommunications that introduces the fundamental concepts and techniques of both analogue and digital communications. This course aims to enable students to be familiar with fundamental concepts and issues, to develop good understanding of basic analogue and digital communication techniques, and to perform simple analysis and assessment of system performance.

From a system engineering perspective, we will find that the developments and advances of telecommunication technologies are closely related to those of electrical engineering and computer engineering. For students who undertake studies in fields other than telecommunications, this course will provide an in-depth overview of the fundamentals as well as modern techniques and systems in the telecommunication field.

Indicative Lecture Schedule

Period	Summary of Lecture Program
Week 1	Course overview, Fundamentals, Review: Fourier and phasors
Week 2	Amplitude modulation: AM, DSB-SC, QAM, SSB, VSB
Week 3	Angle modulation: PM, FM
Week 4	Noise in analogue communications
Week 5	Analogue to digital (I): Sampling & analogue pulse modulation (PAM, PWM, PPM) **Mid-term exam (June 29th, Monday)**
Week 6	Flexibility Week
Week 7	Analogue to digital (II): Quantisation, encoding & digital pulse modulation (PCM, DM, DPCM)
Week 8	Digital band-pass modulation: ASK, FSK, PSK, M-ary signalling Transmission
Week 9	Noise in digital communications
Week 10	Communication systems examples, Review

Analogue to digital (II): Quantisation, encoding & digital pulse modulation (PCM, DM, DPCM)

Indicative Laboratory Schedule

Period	Summary of Laboratory Program
Week 2 (1hr)	**Tutorial on TutorTIMS**
Week 3 (3hr)	**Lab 1:** Introduction to TutorTIMS
Week 4 (3hr)	**Lab 2:** Amplitude Modulation
Week 5 (3hr)	**Lab 3:** Double and Single Sideband Modulation
Week 7 (3hr)	**Lab 4:** Frequency Modulation
Week 8 (3hr)	**Lab 5:** Sampling and Time Division Multiplexing
Week 9 (3hr)	**Lab 6:** Digital Signals: Eye Patterns and Line Codes
Week 10 (3hr)	**Group project presentations**

Assessment

Laboratory Practical Experiments	20%
Mid-term Exam	20%
Group Projects	20%
Final Exam (2 hours)	40%

Note: You need to pass all assessments to pass the unit.

COURSE DETAILS

Credits

This is a 6 UoC course and the expected workload is 15 hours per week throughout the 10-week term.

Relationship to Other Courses

This is a 3rd year course in the School of Electrical Engineering and Telecommunications.

Pre-requisites and Assumed Knowledge

Pre-requisite for the course: ELEC2134 and MATH2099.

It is essential that the students have shown competency in mathematics, electronics, signals and systems in Year 1 and Year 2. They are strongly advised to review previous ELEC2134 and MATH2099 courses materials.

Following Courses

TELE3113 is a pre-requisite for all professional electives offered for BE in Telecommunications. This course builds the ground for the courses like TELE4651, TELE4652, and TELE4653.

Learning outcomes

After successful completion of this course, you should be able to:

1. Understand and apply both time and frequency domain representations of signals
2. Understand and explain analogue and digital modulation and demodulation techniques
3. Understand and be able to implement noise and error analysis

This course is designed to provide the above learning outcomes which arise from targeted graduate capabilities listed in ***Appendix A***. The targeted graduate capabilities broadly support the UNSW and Faculty of Engineering graduate capabilities (listed in ***Appendix B***). This course also addresses the Engineers Australia (National Accreditation Body) Stage I competency standard as outlined in ***Appendix C***.

Syllabus

- Fundamentals: Fourier transform, phasors, spectrum analysis, random signals, Free-space propagation characteristics,.
- Analogue communications: Continuous wave modulation (AM, DSB, SSB, VSB, QAM, FM, and PM), complex envelope, receivers, error and noise analysis.
- Digital communications: Sampling, quantisation, baseband techniques (PAM, PWM, PPM, PCM, DM, and line coding), band-pass techniques (ASK, FSK, PSK, M-ary signalling), multiplexing techniques (FDM, TDM, and quadrature multiplexing), inter-symbol interference and eye diagrams, error and noise analysis.

TEACHING STRATEGIES

Delivery Mode

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

- Online lectures provide you with a focus on the core analytical material in the course, together with qualitative, alternative explanations to aid your understanding;
- Online tutorials provide an opportunity for numerical problem solving in a group and discuss issues and exchange ideas with others in the class.
- Laboratory sessions support the lecture content and provide you with practical construction, measurement and debugging skills using TutorTIMS software;

Learning in this course

You are expected to attend <u>all</u> online lectures, tutorials, labs, and mid-term 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 formal classes throughout the course.

Lectures

The lectures provide the students with the explanation of the core materials in the course. There will be 4 hours of online lectures per week, with corresponding lecture notes.

Tutorial classes

The tutorials enable students to apply various methods to quantitatively analyse the fundamentals of communication systems. 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. Answers for these questions will be discussed during the tutorial class and the tutor will cover the more complex questions.

Laboratory program

The laboratories provide the student with hands-on experience to analyse, design, and test communication systems. The laboratory experiments are concerned with modelling various signals on the one hand, and with carrying out different operations upon signals (e.g. filtering, sampling, demodulating) on the other. This approach intends to provide insights into the properties of, and relationships between, signals which are fundamental to communications engineering.

Students are expected to prepare for each of the laboratory experiments prior to coming into the lab. Every student is required to keep an individual record of all the experiments, preferably in electronic file.

Laboratory Exemption

There is no laboratory exemption for this course. Regardless of whether equivalent labs have been completed in previous courses, all students enrolled in this course must take the labs. If, for medical reasons, (note that a valid medical certificate must be provided) you are unable to attend a lab, you will need to apply for a catch-up lab during another lab time, as agreed by the laboratory coordinator.

ASSESSMENT

The assessment scheme in this course reflects the intention to assess your learning progress through the term. Ongoing assessment occurs through the lab checkpoints (see lab manual), and the mid-term exam.

Laboratory Assessment

Laboratories are primarily about learning, and the laboratory assessment is designed mainly to check your knowledge as you progress through each stage of the laboratory tasks. You are required to maintain a lab book for recording your observations. A lab book is electronic file where you will record your observations for each lab. There will be a tutorial session in Week 1 on the expected output of each lab.

It is essential that you complete the laboratory preparation before coming to the lab. You are required to write the aim of the experiment and draw the circuit diagram if any in your lab book. This will be verified and signed by your demonstrators in the lab. You will be recording your observations/readings in your lab book.

At the end of each lab experiment, the student will be assessed by a lab demonstrator on the understanding and successful completion of the experiment and results obtained.

Students will be assessed individually and assigned a mark based on their demonstration of understanding of experiments. Again, online assessment details will be covered in Week 1 in your allocated Lab session time. Follow the link on Moodle.

Assessment marks will be awarded according to your preparation (completing set preparation exercises and correctness of these or readiness for the lab in terms of pre-reading), how much of the lab you were able to complete, your understanding of the experiments conducted during the lab and your understanding of the topic covered by the lab.

Group Project presentations

A short project topic will be allocated for a group of three students by Week 6. Your group will present in Week 10 in your allocated Lab session. You will have the opportunity to choose your team members for the short project investigation and online presentation in online collaborative Labs and Tutorials. Details regarding presentation topic, submission and guidelines will be posted on Moodle Unit page.

Mid-Term Exam

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 material already covered in the course schedule. 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. Details about the organization of the online test will be available on Moodle.

Final Exam

The exam in this course is a standard 2 hour written examination. 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.

NOTE: *Please note that you must pass the final exam in order to pass the course.*

Relationship of Assessment Methods to Learning Outcomes

	Learning outcomes		
Assessment	**1**	**2**	**3**
Laboratory practical assessments	✓	✓	✓
Group projects	✓	✓	✓
Mid-term exam	✓	✓	-
Final exam	✓	✓	✓

COURSE RESOURCES

Textbooks

Prescribed textbook

- Simon Haykin and Michael Moher, ***An Introduction to Analog & Digital Communications***, 2nd Ed., Wiley, 2007. *Hardcopy:* ISBN 978-0-470-46087-0; *E-book*: ISBN 978-0-470-46087-0

Other useful reference books

- Bruce Carlson, Paul B. Crilly and Janet C. Rutledge, Communication Systems: An Introduction to Signals and Noise in Electrical Communications, 4th Edition, McGraw-Hill, 2002. Hardcopy: ISBN: 0-07-112175-7
- Simon Haykin, Communication Systems, 4th Edition, John Wiley & Sons, 2001.
- Nevio Benvenuto, Roberto Corvaja, Tomaso Erseghe, and Nicola Laurenti, Communication Systems: Fundamentals and Design Methods, John Wiley & Sons, 2006. Hardcopy: ISBN: 978-0-470-01822-4
- Leon W. Couch, Modern Communication Systems: Principles & Applications, Prentice Hall, (P621.382/84), 1995
- B. P. Lathi, Modern Digital & Analog Communication Systems, 2nd Edition, Oxford University Press, (P621.380413/15J) 2009

On-line 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.

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).

OTHER MATTERS

Dates to note

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

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.

Student Responsibilities and Conduct

Students are expected to be familiar with and adhere to UNSW policies (see https://student.unsw.edu.au/guide), 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 online classes and *independent, self-directed study*. In periods where you need to 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.

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.

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.

Continual Course Improvement

This course is under constant revision in order to improve the learning outcomes for all students. Please forward any feedback (positive or negative) on the course to the course convener or via the online student survey myExperience. You can also provide feedback to ELSOC who will raise your concerns at student focus group meetings. As a result of previous feedback obtained for this course and in our efforts to provide a rich and meaningful learning experience, we have continued to evaluate and modify our delivery and assessment methods.

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

APPENDICES

Appendix A: Targeted Graduate Capabilities

Electrical Engineering and Telecommunications programs are designed to address the following targeted capabilities which were developed by the school in conjunction with the requirements of professional and industry bodies:

- The ability to apply knowledge of basic science and fundamental technologies;
- The skills to communicate effectively, not only with engineers but also with the wider community;
- The capability to undertake challenging analysis and design problems and find optimal solutions;
- Expertise in decomposing a problem into its constituent parts, and in defining the scope of each part;
- A working knowledge of how to locate required information and use information resources to their maximum advantage;
- Proficiency in developing and implementing project plans, investigating alternative solutions, and critically evaluating differing strategies;
- An understanding of the social, cultural and global responsibilities of the professional engineer;
- The ability to work effectively as an individual or in a team;
- An understanding of professional and ethical responsibilities;

- The ability to engage in lifelong independent and reflective learning.

Appendix B: UNSW Graduate Capabilities

The course delivery methods and course content directly or indirectly addresses a number of core UNSW graduate capabilities, as follows:

- Developing scholars who have a deep understanding of their discipline, through lectures and solution of analytical problems in tutorials and assessed by assignments and written examinations.
- Developing rigorous analysis, critique, and reflection, and ability to apply knowledge and skills to solving problems. These will be achieved by the laboratory experiments and interactive checkpoint assessments and lab exams during the labs.
- Developing capable independent and collaborative enquiry, through a series of tutorials spanning the duration of the course.

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

	Program Intended Learning Outcomes	
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals	✓
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing	✓
	PE1.3 In-depth understanding of specialist bodies of knowledge	✓
	PE1.4 Discernment of knowledge development and research directions	
	PE1.5 Knowledge of engineering design practice	
	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	
	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	
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	✓