School of Electrical Engineering and Telecommunications

Semester 2, 2018
Course Outline

TELE3113
Analog and Digital Communications

COURSE STAFF

Course Convener: Dr. Alex von Brasch, a.vonbrasch@unsw.edu.au

Consultations: You are encouraged to ask questions on the course material, after the lecture class times in the first instance, rather than via email. 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 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 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 3 hours of lectures per week, a 1-hour tutorial per fortnight, and a 3-hour laboratory session each fortnight. The lectures begin in Week 1, and the Labs and Tutorials in Week 2.

Lectures	**Day**	**Time**	**Location**
	Monday	5pm - 6pm	CLB 4
	Tuesday	2pm - 4pm	Vall 121
Tutorials	Monday	6pm – 7pm	Quad G045
Laboratories	Tue (Odd & Even)	9am – 12pm	EE219
	Fri (Odd & Even)	9am – 12pm	EE219
	Fri (Even)	2pm – 5pm	EE219

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, 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	History of telecommunication and fundamentals of signals and systems
Week 2	AM, DSB-SC, DSB-WC
Week 3	AM, SSB, VSB
Week 4	Angle modulation, Narrowband & wideband FM
Week 5	Angle modulation, FM transmission, PLL
Week 6	Sampling and Quantization, Multiplexing Mid-term Exam
Week 7	Pulse Modulation, PCM, DPCM and Delta modulation
Week 8	Band-pass modulation techniques, M-ary signalling
Week 9	Fundamentals of probability and statistics, Noise, Baseband transmission
Break	
Week 10	Detection theory, Optimal detection theory and Matched filters
Week 11	Source and Channel Coding, Communication Systems Case Studies
Week 12	Communication Systems Case Studies

Indicative Laboratory Schedule

Period	Summary of Laboratory Program
Week 2, 3	**Lab 1:** Introduction to TIMS and MATLAB, Amplitude Modulation
Week 4, 5	**Lab 2:** Double and Single Sideband Modulation
Week 6, 7	**Lab 3:** Frequency Modulation
Week 8, 9	**Lab 4:** Sampling and Time Division Multiplexing
Break	
Week 10, 11	**Lab 5:** Digital Signals: Eye Patterns and Line Codes
Week 12, 13	**Lab 6:** Communication Systems and Performance

Assessment

Laboratory Practical Experiments	20%
Mid-Semester Exam	20%
Final Exam (2 hours)	60%

COURSE DETAILS

Credits

This is a 6 UoC course and the expected workload is 10–12 hours per week throughout the 13 week semester.

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. have a good understanding of both time and frequency domain representations of signals;
2. have a good understanding of analogue modulation and demodulation techniques;
3. have a good understanding of digital modulation and demodulation techniques; and
4. understand and be able to implement noise and error analysis of an analogue or digital telecommunication system.

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

Telecommunication Fundamentals: Free space propagation characteristics, phasors, fourier transform, spectrum analysis, random signals. Analogue: continuous wave modulation (AM, DSB, SSB, VSB, QAM, FM, and PM), complex envelope, receivers, error and noise analysis. Digital: sampling, quantisation, Digital Baseband (PAM, PWM, PPM, PCM, DM, and line coding), Passband: techniques (Binary and M-ary signaling ASK, PSK, FSK, QPSK, QAM), multiplexing techniques (FDM, TDM, and quadrature multiplexing), inter-symbol interference and eye diagrams. Systems: Analogue and Digital PSTN, Satellite Communication fundamentals, Satellite television.

TEACHING STRATEGIES

Delivery Mode

The teaching of the course is delivered through a combination of lectures, tutorials, and laboratory work.

Learning in this course

You are expected to attend all lectures, tutorials, labs, 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.

Lectures

The lectures provide the students with the explanation of the core materials in the course. The lectures will be delivered 3 hour per week with corresponding lecture notes.

Tutorial classes

The tutorials enable students to apply various methods to quantitatively analyze the fundamentals of communication systems. Students are expected to attend the tutorials and attempt to solve given tutorial questions before attending the tutorial.

Laboratory program

The laboratories provide the student with hands-on experience to design, analyze and test the 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 is intended to provide insights into the properties of, and relationships between, many 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 the form of a bound book..

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 course coordinator.

ASSESSMENT

The assessment scheme in this course reflects the intention to assess your learning progress through the semester. Ongoing assessment occurs through the lab checkpoints (see lab manual) and the mid-semester 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 an A4 size notebook containing a mix of plain pages and graph sheets. You have to purchase your own lab book from any store.

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 system 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 successful completion of the experiment and understanding of the experiment and results obtained. Students will be assessed individually.

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.

Mid-Semester Exam

The mid-session 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 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.

Final Exam

The exam in this course is a standard closed-book 2 hour written examination. 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. *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**	**4**
Laboratory practical assessments	✓	✓	✓	✓
Mid-semester 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 978-0-470-46087-0Reference books

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 all 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 **ten to twelve hours per week** studying a 6 UoC course, from Week 1 until the final assessment, including both face-to-face 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 should seek assistance early if you suffer illness or misadventure which affects your course progress. All applications for special consideration must be **lodged online through myUNSW within 3 working days of the assessment**, not to course or school staff. For more detail, consult 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	