School of Electrical Engineering and Telecommunications

Term 1, 2020
Course Outline

TELE3113
Analogue and Digital Communications

COURSE STAFF

Course Convener and Tutor: Dr. Deepak Mishra, d.mishra@unsw.edu.au
Laboratory Contact: Xinyue Lei, xinyue.lei@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

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

<table>
<thead>
<tr>
<th>Period</th>
<th>Summary of Lecture Program</th>
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<tbody>
<tr>
<td>Week 1</td>
<td>Course overview, Fundamentals, Review: Fourier and phasors</td>
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<tr>
<td>Week 2</td>
<td>Amplitude modulation: AM, DSB-SC, QAM, SSB, VSB</td>
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<td>Week 3</td>
<td>Angle modulation: PM, FM</td>
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<td>Week 4</td>
<td>Noise in analogue communications</td>
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<td>Week 5</td>
<td>Analogue to digital (I): Sampling &amp; analogue pulse modulation (PAM, PWM, PPM)</td>
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<tr>
<td>Week 6</td>
<td>Analogue to digital (II): Quantisation, encoding &amp; digital pulse modulation (PCM, DM, DPCM) <strong>Mid-term exam</strong></td>
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<tr>
<td>Week 7</td>
<td>Digital band-pass modulation: ASK, FSK, PSK, M-ary signalling</td>
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<td>Week 8</td>
<td>Transmission</td>
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<td>Week 9</td>
<td>Noise in digital communications</td>
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<td>Week 10</td>
<td>Communication systems examples, Review</td>
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### Indicative Laboratory Schedule

<table>
<thead>
<tr>
<th>Period</th>
<th>Summary of Laboratory Program</th>
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<tr>
<td>Week 4 (3hr)</td>
<td>Lab 1: Introduction to TIMS and MATLAB</td>
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<tr>
<td>Week 5 (3hr)</td>
<td>Lab 2: Amplitude Modulation</td>
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<tr>
<td>Week 7 (3hr)</td>
<td>Lab 3: Double and Single Sideband Modulation</td>
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<tr>
<td>Week 8 (3hr)</td>
<td>Lab 4: Frequency Modulation</td>
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<tr>
<td>Week 9 (3hr)</td>
<td>Lab 5: Sampling and Time Division Multiplexing</td>
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<tr>
<td>Week 10 (3hr)</td>
<td>Lab 6: Digital Signals: Eye Patterns and Line Codes</td>
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### Assessment

- Laboratory Practical Experiments: 20%
- Mid-term Exam: 20%
- Final Exam (2 hours): 60%
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. Have a good understanding of both time and frequency domain representations of signals;
2. Demonstrate competency in analogue modulation and demodulation techniques;
3. Demonstrate competency in digital modulation and demodulation techniques; and
4. 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
- Fundamentals: Free space propagation characteristics, Fourier transform, phasors, spectrum analysis, random signals.
- 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:

- Formal face-to-face lectures, which provide you with a focus on the core analytical material in the course, together with qualitative, alternative explanations to aid your understanding;
- Tutorials, which allow for exercises in problem solving and allow time for you to resolve problems in understanding of lecture material;
- Laboratory sessions, which support the formal lecture material and provide you with practical construction, measurement and debugging skills;

Learning in this course
You are expected to attend all 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 face-to-face 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 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 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 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 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 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.

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-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.
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

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<tr>
<th>Assessment</th>
<th>Learning outcomes</th>
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<tr>
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<td>1</td>
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<tr>
<td>Laboratory practical assessments</td>
<td>✓</td>
</tr>
<tr>
<td>Mid-term exam</td>
<td>✓</td>
</tr>
<tr>
<td>Final exam</td>
<td>✓</td>
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COURSE RESOURCES

Textbooks
Prescribed textbook


Other useful reference books


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](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](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](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](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](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 face-to-face 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.

**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](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://student.unsw.edu.au/guide) [https://www.engineering.unsw.edu.au/electrical-engineering/resources](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 address 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

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<tr>
<th>Program Intended Learning Outcomes</th>
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<tbody>
<tr>
<td>PE1: Knowledge and Skill Base</td>
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<tr>
<td>PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals ✓</td>
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<tr>
<td>PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing ✓</td>
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<tr>
<td>PE1.3 In-depth understanding of specialist bodies of knowledge ✓</td>
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<td>PE1.4 Discernment of knowledge development and research directions</td>
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<td>PE1.5 Knowledge of engineering design practice</td>
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<tr>
<td>PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice</td>
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<tr>
<td>PE2: Engineering Application Ability</td>
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<tr>
<td>PE2.1 Application of established engineering methods to complex problem solving</td>
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<tr>
<td>PE2.2 Fluent application of engineering techniques, tools and resources ✓</td>
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<td>PE2.3 Application of systematic engineering synthesis and design processes ✓</td>
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<tr>
<td>PE2.4 Application of systematic approaches to the conduct and management of engineering projects</td>
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<td>PE3: Professional and Personal Attributes</td>
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