School of Electrical Engineering and Telecommunications

Semester 2, 2018
Course Outline

TELE9754
Coding and Information Theory

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Course Website: https://moodle.telt.unsw.edu.au/course/view.php?id=34854

Consultations Hour:

Tuesday 2pm-3pm
Other Consultation Time: Available upon an appointment made and confirmed by email.

Contact Hours

The course consists of 3 hours of lectures each week.

Class Timetable: http://timetable.unsw.edu.au/2018/TELE9754.html

	Day	Time	Location
Lectures	Monday Weeks 1-12	6pm-9pm	Tyree Energy Technology G16

Course Aims

- The course provides advanced knowledge of coding and information theory widely applied in modern wireless systems. It includes the classical information theory (entropy, mutual information, channel coding theorem and channel capacity), channel coding techniques (block coding and convolutional coding), advanced MIMO theory (MIMO capacity, space-time coding, BLAST), OFDM technique (transmitter/receiver design, space-frequency coding), MIMO-OFDM system & applications (Wireless LAN, WiMAX, LTE-A, etc.).

- The course aims to make students familiar with the advanced knowledge of coding and information theory used in the modern wireless systems and applications, and to enable them to work on relevant projects in wireless systems with some research skills.

Lecture Schedule

TELE9754 S2, 2018	**Monday 6-9 pm**	**Topics**
Week 1	23 July	Review of Probability Theory
Week 2	30 July	Fundamentals of Information Theory
Week 3	6 August	Channel Capacity
Week 4	13 August	Gaussian Channel
Week 5	20 August	Channel Coding
Week 6	27 August	MIMO Theory
Week 7	3 September	Space-Time Coding
Week 8	10 September	OFDM
Week 9	17 September	Research Workshop (Oral Presentation)
Mid semester break (September 22- October 1)		
Week 10	1 October	Public Holiday
Week 11	8 October	Research Workshop (Oral Presentation)
Week 12	15 October	Research Workshop (Oral Presentation)

Assessment

- Research Writing 10%
- Research Presentation 10%
- Research Project 20%
- Final Exam 60%

Credits

- 6 Units of Credit (UoC) value for the course
- 10-12 hours of expected workload per week throughout the 12 week semester

Relationship to Other Courses

TELE9754 is a core course for postgraduate program in telecommunications. It is aimed at students wishing to specialise in telecommunications in their degree, and possibly, their future careers.

TELE9754 is well complemented by TELE9753 Advanced Wireless Communications, which covers comprehensive knowledge of wideband wireless communication design techniques including diversity techniques, multiple access, wideband CDMA, antenna array, space-time processing, multiuser detection, opportunistic communications and interference management.

Pre-requisites:

The minimum pre-requisite for TELE9754 is TELE3113, Analogue and Digital Communications. TELE4653 Digital Modulation and Coding is highly desirable.

Assumed Knowledge:

- A good background of mathematics including probability theory.
- Some knowledge of programming language such as MATLAB or C.
- Be familiar with digital communications including fading channels, modulation, signal detection, etc.

Following Courses

As a core course for postgraduate program in telecommunications, 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.

Learning Outcomes

After successful completion of this course, students should

1. Understand the principles of coding techniques used in digital communication systems
2. Evaluate performance of various coding techniques over fading channels
3. Recognize advances of coding theory in next generation broadband communication systems
4. Perform independent work in wireless system design with some creative problem-solving ability

5. Skill in effective communications through presentations, technical writing and research discussion
6. Appreciate the benefits of teamwork through collaboration with other professionals

This course is designed to provide the above learning outcomes that 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**.

Teaching Strategies

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;

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

Learning in this Course

You are expected to attend all lectures and final exam in order to maximise learning. In addition to the lecture notes, 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.

Assessments

- **Research writing & presentation (20 marks in total)**:
  Each student will choose a research topic by herself/himself within research scope of wireless communications, write a research report on the selected topic, and give an oral presentation (5~8 minutes, exact time allowed will be notified later) with PowerPoint. The research topic is not limited, but consulting course staff is preferred. The writing & presentation will test the abilities of students in retrieving and evaluating literature information, engaging in a particular research topic, writing a technical report and making effective communications.

  The report should be submitted before or on **10 September 2018 (Due Time: 23:59)**. The presentation schedule (**Research Workshop**) will be announced in mid September. Students can prepare for research report and presentation from week 1 and are encouraged to consult lecture staff.

- **Research Project (20 marks)**:
  The project in this course requires students to solve some research problems by giving some analysis and performing computer (Matlab) simulation to validate the analysis. The project will test students the abilities of creative problem solving, independent critical thinking, and teamwork management.

  Project details will be given in early October and students are required to submit project reports before/on **1 November 2018 (Due Time: 23:59)**. Students are encouraged to collaborate with the other student in one group (at most 2 students in one group). Note that the projects vary from different groups. As a penalty, student who is absent in any class without an appropriate excuse must do the project alone.

- **Final Examination (60 marks)**:
  The exam in the course is a standard closed-book written examination, comprising not more than eight compulsory questions. The final examination will test students' understanding of the course material and analytical skills.

Relationship of Assessment Methods to Learning Outcomes

	Learning outcomes					
Assessment	**1**	**2**	**3**	**4**	**5**	**6**
Research Writing	✓	-	✓	-	✓	-
Research Presentation	✓	-	✓	-	✓	-
Research Project	✓	✓	✓	✓	✓	✓
Final Exam	✓	✓	-	✓	-	-

Course References

❖ Reference books

1. Thomas M. Cover and Joy A. Thomas, Elements of Information Theory, 2nd Ed., John Wiley & Sons, 2006.
2. John G. Proakis, Digital Communications, 5th Ed., McGraw-Hill, 2007.
3. Robert J. McEliece, The Theory of Information and Coding, 2nd Ed., Cambridge University Press, 2002.
4. Erik G. Larsson and Petre Stoica, Space-time Block Coding for Wireless Communications, Cambridge University Press, 2003.

On-line Resources

Moodle

As a part of the teaching component, Moodle will be used to disseminate teaching materials. 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 UNSW email address).

Other Matters

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 http://www.lc.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://my.unsw.edu.au/student/atoz/ABC.html), 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://my.unsw.edu.au/student/atoz/SpecialConsideration.html.

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 Course and Teaching Evaluation and Improvement Process. 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.

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 the Course and Teaching Evaluation and Improvement (CATEI) tool.

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:
http://www.engineering.unsw.edu.au/electrical-engineering/policies-and-procedures
https://my.unsw.edu.au/student/atoz/ABC.html

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.
- Developing digital and information literacy and lifelong learning skills through assignment work.

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	✓