School of Electrical Engineering and Telecommunications

Term 3, 2020
Course Outline

TELE9782
Special Topics in Telecommunications
Antenna and Propagation

Course Staff

Course convener: Dr. Shaghik Atakaramians, Room # 414, Building G17
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Moodle: https://moodle.telt.unsw.edu.au/course/view.php?id=53967

Course project student mentor: Syed Daniyal Ali Shah, daniyal.shah@unsw.edu.au

Consultations: You are encouraged to ask questions on the course material, during the on-line lectures. If required, all email enquiries should be made from your student email address with TELE9782 in the subject line; otherwise they will not be answered.

Keeping Informed: Most announcements will be made via Moodle. 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 on-line sessions and an group course project using CST. The on-line session will be organised using either Microsoft Teams or Blackboard collaborate and course project sessions can be completed in rm 108 (G17) either connecting remotely or attending in person according to the following schedule:

	Day	Time and Location
Lectures	Tue 15/9	12 – 2 pm on-line, 2 – 3 pm 108 (G17) or on-line
	Tue 22/9	12 – 2 pm on-line, 2 – 3 pm 108 (G17) or on-line
	Tue 29/9	12 – 2 pm on-line, 2 – 3 pm 108 (G17) or on-line
	Tue 6/10	12 – 2 pm on-line, 2 – 3 pm 108 (G17) or on-line
	Tue 13/10	12– 2 pm on-line, 2 – 3 pm 108 (G17) or on-line
	Tue 20/10	12 – 2 pm on-line, 2 – 3 pm 108 (G17) or on-line
	Tue 27/10	12 – 2 pm on-line, 2 – 3 pm 108 (G17) or on-line
	Tue 3/11	12 – 2 pm on-line, 2 – 3 pm 108 (G17) or on-line
	Tue 10/11	12 – 2 pm on-line, 2 – 3 pm 108 (G17) or on-line
	Tue 17/11	12 – 3 pm on-line,

Context and Aims

Context:

An antenna is a transitional structure that converts the electromagnetic waves into electric signals known as electric current that are transferred to a receiver using waveguides. An antenna in communication system has the same purpose as the eye for humans. The human eye converts the invisible light into electrical signals known as nerve impulses that are transferred to our brain via optic nerve and then is processed into images. On the contrary to human eye, the antenna also converts the electric signal from a transmitter into electromagnetic waves.

The antenna is an indispensable part of the communication, sensing and imaging systems. With the recent grow of wireless system and smart devices, reliable connection between the devices is the focus of many stake holders, which can be achieved with the proper antenna design techniques.

Aims: This course main objective is to introduce the fundamental principles of the antenna theory and to apply them to analyse and design basic antenna both analytically and using numerical software CST Studio Suite. After taking the course, you should have a thorough knowledge of fundamental parameters and Figure-of-Merit of antennas and will be able to design single and array antenna using CST for the basic antenna structure and expand your learnings into other antenna design.

Topics covered comprise: Fundamental Parameters and Figure-of-Merit of Antennas, Radiation Integrals and Auxiliary Potential Functions, Linear Wire Antennas, Loop Antennas, Linear Array, Metallic waveguides and horn antenna, Broadband Dipoles and an active learning project.

Indicative Lecture Schedule

Period	Summary of Lecture Program
Week 1	Fundamental Parameters and Figure-of-Merit of Antennas
Week 2	Radiation Integrals and Auxiliary Potential Functions
Week 3	Linear Wire Antennas
Week 4	Linear Array
Week 5	Mid-term exam
Week 6	Loop Antennas
Week 7	Dipole near or on a perfect conductor
Week 8	Metallic waveguides and horn antenna
Week 9	Presentation discussion and problem solving
Week 10	Student individual presentation

Assessment

Course project report and presentation	35%
CST Tutorials	15%
Mid-Semester Exam	20%
Final Exam	30%

Important Health Related Notice

Your health and the health of those in your class is critically important. You must stay at home if you are sick or have been advised to self-isolate by NSW health or government authorities. Current alerts and a list of hotspots

can be found here. **You will not be penalised for missing a face-to-face activity due to illness or a requirement to self-isolate**. We will work with you to ensure continuity of learning during your isolation and have plans in place for you to catch up on any content or learning activities you may miss. Where this might not be possible, an application for fee remission may be discussed.

If you are required to self-isolate and/or need emotional or financial support, please contact the Nucleus: Student Hub. If you are unable to complete an assessment, or attend a class with an attendance or participation requirement, please let your teacher know and apply for special consideration through the Special Consideration portal. To advise the University of a positive COVID-19 test result or if you suspect you have COVID-19 and are being tested, please fill in this form.

UNSW requires all staff and students to follow NSW Health advice. Any failure to act in accordance with that advice may amount to a breach of the Student Code of Conduct. Please refer to the Safe Return to Campus guide for students for more information on safe practices.

Course Details

Credits

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

Relationship to Other Courses

The course is a fourth-year professional elective offered to students following a BE (TELE and ELEC) course at UNSW. The course gives the foundations for antenna and propagation.

Pre-requisites and Assumed Knowledge

The pre-requisite for the course is ELEC3115, Electromagnetic Engineering or equivalent course. Students who are not confident in their knowledge from Electromagnetic Engineering are strongly advised to revise Part B: Wave electromagnetics course materials as quickly as possible to avoid difficulties in this course.

Learning outcomes

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

1. Define and describe the fundamental parameters and Figure-of-Merit of antennas
2. Calculate and compare the electric and magnetic field components of electric and magnetic dipole antennas from radiation integrals and auxiliary potential functions
3. Study and analyse the effect of ground plane on the antenna performance
4. Design a linear array of N elements with specific required beam pattern and directivity
5. Design a metallic waveguide and transform it into an antenna
6. Understand, analyse and design other similar antenna structure not covered in the course

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***.

Teaching Strategies

Delivery Mode

- On-line Lectures and discussions, which provide you with a focus on the core analytical material in the course, together with qualitative, alternative explanations to aid your understanding;
- On-line mentoring sessions that will promote group work and enhance deeper learning of the concepts.

Learning in this course

You are expected to attend all on-line sessions, course project sessions, and mid-semester exams in order to maximise learning. 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 encouraged. UNSW *assumes* that self-directed study of this kind is undertaken in addition to attending face-to-face sessions throughout the course.

Assessment

The assessment scheme in this course reflects the intention to assess your learning progress through the semester. The assessment occurs through, class participation and quizzes, APL and the mid-semester and final exam.

CST Tutorials (summative assessment, 15%)

You will be given two tutorials to complete, where you will learn how to use CST numerical software to design an electric dipole and antenna array. These tutorials are required to be completed individually and submitted in week 3 and 6 as highlighted as Submission 2 and Submission 3 in the following table.

Course project (formative assessment, report 20% & presentation 15%)

For the project, it is expected the students from a group of two and each group to ***find an interesting scenario where an antenna is being used***, identify the antenna type, understand how the antenna operates, summarize the specific antenna characteristics (pattern, beamwidth, directivity, input impedance and polarization), design the antenna for a specific case using analytical equations, implement and optimize the design using numerical software CST.

Example of interesting antenna scenarios are:

- highly directional broadband antenna widely used to receive TV signals (Yagi-Uda antenna)
- an ultra-wideband conformal antenna for wireless capsule endoscopy (meandered loop antenna)

It is expected that each group submit a **course project report** (20% towards the course) and deliver a 10-15 minutes **presentation** (15% towards the course) in Week 10.

Project report and presentation indicative schedule and deliverables

Period	2-3 pm Tuesdays	Out of lecture	Assessment
Week 1	Completing assigned CST tutorial 1	Selecting the project scenario	
Week 2			
Week 3	Discussion on project topic and outline	Finalising project topic and outline Antenna operation and characteristic	Submission 1 Monday Week 3 (12pm) Submission 2 Friday Week 3 (12pm)
Week 4	Completing assigned CST tutorial 2 Discussion on antenna characteristics	Understanding the antenna characteristics	
Week 5		Finalizing the design and start implementing in CST	

Week 6	Assistant with CST design	CST implementation	Submission 3 Monday Week 6 (12pm)
Week 7	Assistant with CST design	Design optimization	
Week 8	Discussion on the design outcome	Further simulation, report writing and presentation preparation	
Week 9	Discussion on the presentation outline	Finalizing the report for submission and presentation preparation	Submission 4 Friday Week 9 (12pm)
Week 10	Presentation (10-15 minutes each)	presentation preparation	

Submission 1: CST tutorial report 1 (5% of the final mark), individual submission
Submission 2: Project topic and outline (5% of the final mark)
Submission 3: CST tutorial report 2 (10% of the final mark), individual submission
Submission 4: Project Report (15% of the final mark)
Presentation: will be held 12-3pm on-line, all the student are expected to attend (15% of the final mark)

Project Report Specification

- The report must be submitted as **one single pdf file**.
- Page size must be A4 (210 x 297 mm). Page margins must not be less than: 25mm (left and right edges), 25mm (upper edge), and 20mm (lower edge).
- Project must be prepared using a word processor, e.g Microsoft Office or LaTeX.
- The report must include a **title page** with the following details:

THE UNIVERSITY OF NEW SOUTH WALES

SCHOOL OF ELECTRICAL ENGINEERING AND TELECOMMUNICATIONS

TELE 9782 course project

Title of Project

Name of Authors

Submission Date (month and year)

- The cover sheet provided should be included immediately following the title page.
- The summary of the projects (main objects and outcomes) should be included immediately following the cover sheet.
- All pages must be numbered. The main body of the project must be numbered consecutively from beginning to end. Other sections must either be included or have their own logical numbering system.
- Graphs, diagrams and photographs should be inserted as close as possible to their first reference in the text. Rotated graphs etc are to be arranged so as to be conveniently read, with the bottom edge to the outside of the page.
- The author of the project is responsible for the preparation of the project before the deadline, proofreading the typescript and having corrections made as necessary.

The rubric for project report and presentation is available in Moodle.

Mid-Semester Exam (20%)

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 4. Marks will be assigned according to the correctness of the responses. The test is of 2 hours duration, and will be held on-line **Week 5 Tuesday 12-2 pm AEST**. This assessment provides 20% contribution towards your course.

Final Exam (30%)

The exam in this course is an on-line exam, covering all aspects of the course. The examination tests analytical and critical thinking and general understanding of the course material in a controlled fashion.

Relationship of Assessment Methods to Learning Outcomes

	Learning outcomes					
Assessment	**1**	**2**	**3**	**4**	**5**	**6**
Course project report and presentation	✓	-	-	-	-	✓
CST Tutorials	-	✓	-	✓	-	-
Mid-semester exam	✓	✓	-	✓	-	-
Final exam	✓	-	✓	✓	✓	-

Course Resources

Textbooks

Prescribed textbook

- C. A. Balanis, *Antenna Theory : analysis and design*, 4th Edition, Wiley-Interscience, 2016.

Reference books

- C. A. Balanis, *Advanced Engineering Electromagnetics,* 2th Edition, Wiley-Interscience, 2012.
- W. L. Stutzman and G. A. Thiele, *Antenna Theory and design*, 3rd edition, Wiley, 2012.
- J. J. Carr, Practical Antenna Handbook, 4th Edition, MaGraw-Hill.

On-line resources

Moodle https://moodle.telt.unsw.edu.au/course/view.php?id=44542

Occasionally Moodle may be used to host quizzes. Information on this will be made available later.

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 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 **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 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 assessments 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 **before** the exam or 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 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 myExperience. You can also provide feedback to ELSOC who will raise your concerns at student focus group meetings. This year the course project has been redesigned to a team based project and to support the recently added course learning objective (# 6).

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 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 ethical practitioners who are collaborative and effective team workers, through group activities, lab work and tutorials.

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	✓