UNSW Course Outline

ZEIT3220 Engineering Electromagnetics - 2024

Published on the 11 Feb 2024

General Course Information

Course Code : ZEIT3220
Year : 2024
Term : Semester 1
Teaching Period : Z1
Is a multi-term course? : No
Faculty : UNSW Canberra
Academic Unit : School of Engineering and Technology
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : UNSW Canberra at ADFA
Campus : UNSW Canberra
Study Level : Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

The focus of this course is on developing an understanding of the electromagnetic properties of electronic circuits and electromagnetic devices from an electrical engineering perspective. This course builds upon previous courses in electromagnetics and circuit theory, focussing on the

design and utilisation of electromagnetic devices in practical situations. This course will cover transmission lines, revisit Maxwell's equations, develop free-space propagation concepts, and apply those concepts to waveguides and antennas.

Course Aims

This 6 UoC course aims to provide you with an understanding of electromagnetic technology, circuits and devices from an electrical engineering perspective. This course builds upon previous courses in electromagnetics and circuit theory, with a focus on how this technology may be applied in practical situations.

Specific topics covered include:

Unit 1 - Transmission Lines: structures, transmission line parameters, characteristic impedance, propagation coefficient, reflection and transmission coefficients, transmission line applications.

Unit 2 - Fields and Sources: a detailed overview of electromagnetics building up towards the Maxwell's equations and electromagnetic boundary conditions.

Unit 3 - Plane Wave Propagation: wave equation and time harmonic fields; propagation in lossless and lossy media, normal and oblique incidence to boundaries, reflection and transmission; polarization

Unit 4 - Waveguides: TEM, TE and TM propagation; field theory for metallic and dielectric waveguides; losses, modes, cutoff, wavelength, dispersion and bandwidth.

Unit 5 - Antennas: radiation pattern, polarisation, directivity, gain, impedance; wire and loop antennas, aperture antennas; antenna arrays; link budget and RADAR cross-section.

Relationship to Other Courses

Prerequisite courses: ZPEM2502, ZPEM2309, ZPEM2310

Engineering Electromagnetics relies on Physics 2B to a large extent. Unit 2 represents a short overview of pertinent Physics 2B topics.

The class is terminal from the perspective of the current EE program. However, it features maths that are prevalent in other areas. Undetaking ZEIT3220 before ZEIT4225 (RADAR) is helpful.

Course Learning Outcomes

Course Learning Outcomes	Engineers Australia - Professional Engineer (Stage 1)
CLO1 : determine the propagation characteristics of transmission line structures, and manipulate transmission line parameters to solve specific technical problems	• PEE1.1 : Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline • PEE1.2 : Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline • PEE1.3 : In-depth understanding of specialist bodies of knowledge within the engineering discipline • PEE2.1 : Application of established engineering methods to complex engineering problem solving • PEE3.2 : Effective oral and written communication in professional and lay domains • PEE3.5 : Orderly management of self, and professional conduct
CLO2 : model and characterise the propagation behaviour of plane waves propagating in real world environments;	• PEE1.1 : Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline • PEE1.2 : Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline • PEE1.3 : In-depth understanding of specialist bodies of knowledge within the engineering discipline • PEE2.1 : Application of established engineering methods to complex engineering problem solving • PEE3.2 : Effective oral and written communication in professional and lay domains • PEE3.5 : Orderly management of self, and professional conduct
CLO3 : derive the mode structure of simple metallic waveguides; discuss the properties of more complex waveguides and their modes; calculate important parameters relating to waveguides	• PEE1.1 : Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline • PEE1.2 : Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which

	underpin the engineering discipline • PEE1.3 : In-depth understanding of specialist bodies of knowledge within the engineering discipline • PEE2.1 : Application of established engineering methods to complex engineering problem solving • PEE3.2 : Effective oral and written communication in professional and lay domains • PEE3.5 : Orderly management of self, and professional conduct
CLO4 : recognise antenna structures and estimate their key performance characteristics; and apply antenna theory to the solution of simple radio communication and radar problems	• PEE1.1 : Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline • PEE1.2 : Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline • PEE1.3 : In-depth understanding of specialist bodies of knowledge within the engineering discipline • PEE2.1 : Application of established engineering methods to complex engineering problem solving • PEE3.2 : Effective oral and written communication in professional and lay domains • PEE3.5 : Orderly management of self, and professional conduct

Course Learning Outcomes	Assessment Item
CLO1 : determine the propagation characteristics of transmission line structures, and manipulate transmission line parameters to solve specific technical problems	• Exam • Take Home Tests • Lab Reports
CLO2 : model and characterise the propagation behaviour of plane waves propagating in real world environments;	• Exam • Take Home Tests
CLO3 : derive the mode structure of simple metallic waveguides; discuss the properties of more complex waveguides and their modes; calculate important parameters relating to waveguides	• Lab Reports • Exam • Take Home Tests
CLO4 : recognise antenna structures and estimate their key performance characteristics; and apply antenna theory to the solution of simple radio communication and radar problems	• Lab Reports • Exam • Take Home Tests

Learning and Teaching Technologies

Moodle - Learning Management System

Learning and Teaching in this course

SR05 enables a collaborative/interactive blended-mode tutorials.

The Learning Management System

Moodle is the Learning Management System used at UNSW Canberra. All courses have a Moodle site which will become available to students at least one week before the start of semester. Please find all help and documentation (including Blackboard Collaborate) at the Moodle Support page.

UNSW Moodle supports the following web browsers:

» Google Chrome 50+
» Safari 10+
** Internet Explorer is not recommended

** Addons and Toolbars can affect any browser's performance.

Operating systems recommended are:

Windows 7, 10, Mac OSX Sierra, iPad IOS10

For further details about system requirements click here.

Log in to Moodle here.

If you need further assistance with Moodle:

For enrolment and login issues please contact:
IT Service Centre
Email: itservicecentre@unsw.edu.au
Phone: (02) 9385-1333
International: +61 2 9385 1333

For all other Moodle issues please contact:

External TELT Support

Email: externalteltsupport@unsw.edu.au

Phone: (02) 9385-3331

International: +61 2 938 53331

Opening hours:

Monday – Friday 7:30am – 9:30 pm

Saturday & Sunday 8:30 am – 4:30pm

Additional Course Information

Referencing

In this course, students are required to reference following the APA 7 / Chicago NB referencing style. Information about referencing styles is available at: https://guides.lib.unsw.adfa.edu.au/c.php?g=472948&p=3246720

Study at UNSW Canberra

https://www.unsw.adfa.edu.au/study

Study at UNSW Canberra has lots of useful information regarding:

- Where to get help
- Administrative matters
- Getting your passwords set up
- How to log on to Moodle
- Accessing the Library and other areas.

Additional Information as required

CRICOS Provider no. 00098G

The University of New South Wales Canberra.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Exam Assessment Format: Individual	30%	Start Date: Not Applicable Due Date: Not Applicable
Take Home Tests Assessment Format: Individual	40%	Start Date: Not Applicable Due Date: Not Applicable
Lab Reports Assessment Format: Individual	30%	Start Date: Not Applicable Due Date: Not Applicable

Assessment Details

Exam

Course Learning Outcomes

- CLO1 : determine the propagation characteristics of transmission line structures, and manipulate transmission line parameters to solve specific technical problems
- CLO2 : model and characterise the propagation behaviour of plane waves propagating in real world environments;
- CLO3 : derive the mode structure of simple metallic waveguides; discuss the properties of more complex waveguides and their modes; calculate important parameters relating to waveguides
- CLO4 : recognise antenna structures and estimate their key performance characteristics; and apply antenna theory to the solution of simple radio communication and radar problems

Detailed Assessment Description

There is no tech-fail in this class; however, to emulate a tech-fail-like incentive, the final exam mark is thresholded instead. The exam will have 40pts, with the score being calculated out of 30pts. This represents a 25% threshold which is designed to do the following:

1. give students additional confidence of not being afraid of tech-failing
2. require a strong final exam performance to bolster the final mark
3. fairly link the threshold to the Q+G replacement marks offered throughout the course

Thresholding will be proportional per problem, i.e., if the exam were to have four 10pts problems, the marks in excess of 2.5pts on each problem will contribute to the final exam score.

Assessment Length

2 hours

Assessment information

Students will be allowed to bring the following to the exam:

- Complex-arithmetic capable scienftific calculator
- 1 sheet of A4 paper written on both sides (NOT photocopied or reduced)
- Mechanical drawing instruments, such as a compass or a protractor

Assignment submission Turnitin type

This is not a Turnitin assignment

Take Home Tests

Assessment Overview

Five take home tests weighted 8%

Course Learning Outcomes

- CLO1 : determine the propagation characteristics of transmission line structures, and manipulate transmission line parameters to solve specific technical problems
- CLO2 : model and characterise the propagation behaviour of plane waves propagating in real world environments;
- CLO3 : derive the mode structure of simple metallic waveguides; discuss the properties of more complex waveguides and their modes; calculate important parameters relating to waveguides
- CLO4 : recognise antenna structures and estimate their key performance characteristics; and apply antenna theory to the solution of simple radio communication and radar problems

Detailed Assessment Description

The Take Home Test (THT) mark comprises 40 best 1%-performances from a total of fifty

50 opportunities:

- 7 problems on each THT1 (individual submission), each worth 1%
- 7 problems on each THT2 (individual submission), each worth 1%
- 7 problems on each THT3 (individual submission), each worth 1%
- 7 problems on each THT4 (individual submission), each worth 1%
- 7 problems on each THT5 (individual submission), each worth 1%
- 10 games (group submission), each worth 1%
- 5 quiz problem (individual submission), each worth 1%

Quizzes and Games (Q+G) will be held within the scheduled class times (typically within the first 20 minutes of the 1h50min blended lecture/tutorial session). Q+G are open-book and collaborative. Each student must submit their own quiz via Moodle, whereas games require a single (written) submission per team. Each student's Q+G scores will be kept track of on and individual basis, whereby the 15 Q+G marks are added into the mix with the 35 raw-THT marks.

Best 40 of 50 are selected, i.e., SUM(LARGE(A1:A50,1:40)). This overloading into the composite THT mark is meant as a positive/safety-net-like incentive to encourage students to keep up with the course material and bolster class participation overall. It is also a preview of what future THT and Exam problems might look like.

The THT submission due dates are:

- THT1 - Monday, 18 March, 2024 at 23:59
- THT2 - Monday, 1 April, 2024 at 23:59
- THT3 - Monday, 6 May, 2024 at 23:59
- THT4 - Monday, 20 May, 2024 at 23:59
- THT5 - Monday, 3 June, 2024 at 23:59

Assessment Length

Each Take Home Test will be given 60hrs to complete.

Assignment submission Turnitin type

This is not a Turnitin assignment

Lab Reports

Course Learning Outcomes

- CLO1 : determine the propagation characteristics of transmission line structures, and manipulate transmission line parameters to solve specific technical problems
- CLO3 : derive the mode structure of simple metallic waveguides; discuss the properties of more complex waveguides and their modes; calculate important parameters relating to waveguides
- CLO4 : recognise antenna structures and estimate their key performance characteristics; and apply antenna theory to the solution of simple radio communication and radar problems

Detailed Assessment Description

Two laboratory exercises will be conducted during the course. These are:

- Lab 1: Transmission Lines and Matching
- Lab 2: Guided Waves and Antennas

Each of these laboratory exercises run over a number of weeks, and will be conducted during the weekly 2-hour lab period in the Electrical Engineering Teaching Laboratories (Rooms 114/116, Building 16). You are required to submit Lab Reports at the completion of Lab #1 and Lab #2 activities. These reports provide you with the opportunity to demonstrate your understanding of the material, and draw on various concepts and techniques covered in this and other courses in the program.

The Lab Report submission due dates are:

- Lab 1 - Friday, 26 April, 2024 at 23:59
- Lab 2 - Friday, 7 June, 2024 at 23:59

Assessment Length

No more than 8 pages

Assessment information

A detailed marking guide will be made available on Moodle.

Assignment submission Turnitin type

This assignment is submitted through Turnitin and students do not see Turnitin similarity reports.

General Assessment Information

Take Home Test replacement marks and Exam thresholding are designed together whereby students are benefitted in the lead-up to the Exam to make passing more likely, but then the Exam thresholding re-emphasises the need to excel in a time-pressured and closed-book environment to achieve distinction.

THT1 will be due in week 4, feedback and grades will be given to students during week 4.

Standard UNSW late assessment policy applies in this class:

- Unless prior arrangement is made with the lecturer or a formal application for special consideration is submitted, a penalty of 5% of the total available mark for the assessment will apply for each day that an assessment item is late up to a maximum of 5 days (120 hours) after which an assessment can no longer be submitted and a grade of 0 will be applied.
- no permitted variation.

Generative AI is a tool that should be used with utmost care. It can often get confused and hallucinate information that ends up providing the user with incorrect and/or irrelevant information given the specified context. Irrelevant (but correct) information is likely to be ignored in marking; non-citability of AI-generated information is a further likely detriment against evaluation of understanding. Quiz, Game and THT questions are regularly checked against generative AI tools.

Grading Basis

Standard

Requirements to pass course

In order to satisfactorily complete this course students must achieve an overall mark of 50% or greater in the overall course assessment.

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 26 February - 1 March	Lecture	U1 L1 Transients U1 L2 Telegraphist's Eqs. U1 L3 Characteristic Impedance U1 L4 Smith Chart
	Laboratory	Lab 1 - ADS introduction
Week 2 : 4 March - 8 March	Lecture	U1 L5 S-parameters U1 L6 Matching + Power U1 L7 Lossy Lines U1 L8 Coaxial Cable
	Laboratory	LAB 1A - Time Domain
Week 3 : 11 March - 15 March	Lecture	U1 Review U2 L1 Fields + Sources U2 L2 Charge + Coulomb's law U2 L3 Electrostatics
	Laboratory	LAB 1B - Frequency Domain and Dielectric Coefficient
Week 4 : 18 March - 22 March	Lecture	U2 L4 Magnetostatics U2 L5 Lorentz Force U2 L6 Dipoles U2 L7 Materials
	Laboratory	LAB 1C - Matching Networks
	Assessment	THT1
Week 5 : 25 March - 29 March	Lecture	U2 L8 Maxwell's Equations + Boundary Conditions U2 Review U3 L1 Wave + Helmholtz Equations U3 L2 Wavefronts + Interference
	Laboratory	LAB 1C - Matching Networks
Week 6 : 1 April - 5 April	Lecture	U3 L3 Power + Energy U3 L4 Velocity + Interfaces U3 L5 Reflection + Refraction U3 L6 Normal Incidence
	Laboratory	LAB 1 - Catch-up
	Assessment	THT2
Week 7 : 22 April - 26 April	Lecture	U3 L7 Polarization U3 L8 Lossy Media
	Laboratory	No lab sessions due to days missed
	Assessment	Lab 1 Report
Week 8 : 29 April - 3 May	Lecture	U3 Review U4 L1 Energy Transport + Modes U4 L2 Parallel Plate U4 L3 Rectangular Waveguides I
	Laboratory	Lab 2 - CST introduction
Week 9 : 6 May - 10 May	Lecture	U4 L4 Rectangular Waveguides II U4 L5 Coaxial Cable U4 L6 Twisted Pair U4 L7 Dielectrics Waveguides
	Laboratory	Lab 2A - Transmission Line Terminations
	Assessment	THT3
Week 10 : 13 May - 17 May	Lecture	U4 L8 Optical Fiber U4 Review U5 L1 Radiation U5 L2 A potential + Small dipoles
	Laboratory	Lab 2B - Metallic Waveguides
Week 11 : 20 May - 24 May	Lecture	U5 L3 Resonant Dipoles U5 L4 Linear Arrays U5 L5 Friss Transmission Equation U5 L6 RADAR + SNR
	Laboratory	Lab 2C - Horn Antennas
	Assessment	THT4
Week 12 : 27 May - 31 May	Lecture	U5 L7 Other Antennas I U5 L8 Other Antennas II U5 Review
	Laboratory	Lab 2C - Horn Antennas
Week 13 : 3 June - 7 June	Lecture	CEA tour (to be confirmed) G9+GX - Semifinal and Final
	Laboratory	Lab slot may be used either for the CEA tour or catch-up
	Assessment	THT5 Lab 2 Report

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

Course Resources

Prescribed Resources

Wentworth, *Applied Electromagnetics*, Wiley 2007

Recommended Resources

Sophocles J. Orfanidis*, Electromagnetic Waves and Antennas* (https://www.ece.rutgers.edu/~orfanidi/ewa/)

Additional Costs

N/A

Course Evaluation and Development

By design, ZEIT3220 follows a learning-through-assessment philosophy. This has often meant that students found the amount of assessment in ZEIT3220 to be more than in other classes. A change this year is a reduction in number of problems on each Take Home Tes from eight to seven. The number of assessed 1%-performances is reduced from 58 to 50. Exam thresholding has been eased as a result as well. Personalised detailed feedback on those performances will aim to provide feedback constructive enough to prevent mistakes of the same kind in future topics and the Exam.

One of the key priorities in the 2025 Strategy for UNSW is a drive for academic excellence in education. One of the ways of determining how well UNSW is progressing towards this goal is by listening to our own students. Students will be asked to complete the myExperience survey towards the end of this course.

Students can also provide feedback during the semester via: direct contact with the lecturer, the “On-going Student Feedback” link in Moodle, Student-Staff Liaison Committee meetings in schools, informal feedback conducted by staff, and focus groups. Student opinions really do make a difference. Refer to the Moodle site for this course to see how the feedback from previous students has contributed to the course development.

Important note: Students are reminded that any feedback provided should be constructive and

professional and that they are bound by the Student Code of Conduct Policy

https://www.gs.unsw.edu.au/policy/documents/studentcodepolicy.pdf

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Discipline coordinator	Andrey Alenin		Bldg 16 Room 206	02 5114 5114	On request	Yes	Yes

Other Useful Information

Academic Information

Course Evaluation and Development

One of the key priorities in the 2025 Strategy for UNSW is a drive for academic excellence in education. One of the ways of determining how well UNSW is progressing towards this goal is by listening to our own students. Students will be asked to complete the myExperience survey towards the end of each course.

Students can also provide feedback during the semester via: direct contact with the lecturer, the “On-going Student Feedback” link in Moodle, Student-Staff Liaison Committee meetings in schools, informal feedback conducted by staff, and focus groups (where applicable). Student opinions really do make a difference. Refer to the Moodle site for your course to see how the feedback from previous students has contributed to the course development.

Important note: Students are reminded that any feedback provided should be constructive and professional and that they are bound by the Student Code of Conduct.

https://www.gs.unsw.edu.au/policy/documents/studentcodepolicy.pdf

Equitable Learning Services (ELS)

Students living with neurodivergent, physical and/or mental health conditions or caring for someone with these conditions may be eligible for support through the Equitible Learning Services team. Equitable Learning Services is a free and confidential service that provides practical support to ensure your mental or physical health conditions do not adversely affect

your studies.

Our team of dedicated **Equitable Learning Facilitators** (ELFs) are here to assist you through this process. We offer a number of services to make your education at UNSW easier and more equitable.

Further information about ELS for currently enrolled students can be found at: https://www.student.unsw.edu.au/equitable-learning

Academic Honesty and Plagarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW staff and students have a responsibility to adhere to this principle of academic integrity. All students are expected to adhere to UNSW's Student Code of Conduct. Find relevant information at: Student Code of Conduct (unsw.edu.au)

Plagiarism undermines academic integrity and is not tolerated at UNSW. It is defined as using the words or ideas of others and passing them off as your own, and can take many forms, from deliberate cheating to accidental copying from a source without acknowledgement.

For more information, please refer to the following:

https://student.unsw.edu.au/plagiarism

Submission of Assessment Tasks

Special Consideration

Special Consideration is the process for assessing and addressing the impact on students of short-term events, that are beyond the control of the student, and that affect performance in a specific assessment task or tasks.

Applications for Special Consideration will be accepted in the following circumstances only:

- Where academic work has been hampered to a substantial degree by illness or other cause;
- The circumstances are unexpected and beyond the student's control;
- The circumstances could not have reasonably been anticipated, avoided or guarded against by the student; and either:

    (i) they occurred during a critical study period and was 3 consecutive days or more

duration, or a total of 5 days within the critical study period; or

(ii) they prevented the ability to complete, attend or submit an assessment task for a specific date (e.g. final exam, in class test/quiz, in class presentation)

Applications for Special Consideration must be made as soon as practicable after the problem occurs and at the latest within three working days of the assessment or the period covered by the supporting documentation.

By sitting or submitting the assessment task the student is declaring that they are fit to do so and cannot later apply for Special Consideration (UNSW 'fit to sit or submit' requirement).

Sitting, accessing or submitting an assessment task on the scheduled assessment date, after applying for special consideration, renders the special consideration application void.

Find more information about special consideration at: https://www.student.unsw.edu.au/special/consideration/guide

Or apply for special consideration through your MyUNSW portal.

Late Submission of assessment tasks (other than examinations)

UNSW has a standard late submission penalty of:

- 5% per day,
- capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, and
- no permitted variation.

Students are expected to manage their time to meet deadlines and to request extensions as early as possible before the deadline.

Electronic submission of assessment

Except where the nature of an assessment task precludes its electronic submission, all assessments must be submitted to an electronic repository, approved by UNSW or the Faculty, for archiving and subsequent marking and analysis.

Release of final mark

All marks obtained for assessment items during the session are provisional. The final mark as

published by the university following the assessment review group meeting is the only official mark.