UNSW Course Outline

ZEIT4227 Radar Techniques and Applications - 2024

Published on the 11 Feb 2024

General Course Information

Course Code : ZEIT4227
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

Radar Fundamentals; Radar Application; Pulse Radar Concepts: Range-Related Calculations, Blind Range, Range Resolution, Maximum Unambiguous Range; Radar Antennas; Radar Range Equation; Pulse Integration; Radar Cross Section; Continuous Wave Radar Concepts; Frequency-

Modulated Continuous Wave Radar Concepts; Pulse Doppler Radar Concepts; Moving Target Identification Radar Concepts; Tracking Radar Techniques: Target Acquisition, Sequential Lobbing, Conical Scanning, Monopulse Tracking Techniques, Scan on Receive Only, Range Tracking, Velocity Tracking; Pulse Compression Radar Concepts: Range Resolution, Blind Range, Design Issues; Synthetic Aperture Radar Concepts: Unfocussed and Focussed Synthetic Aperture Radar, Beamwidth, Angular Resolution; Inverse Synthetic Aperture Radar Concepts; Radar Receiver Techniques; Imaging Radar; Range and Cross-Range Resolution; Image Formation and Characteristics; Backscatter Characteristics of Targets and Clutters.

Course Aims

This course aims at providing an introduction to radar fundamentals, principles and techniques used in both surveillance systems and environmental remote sensing programs.

Relationship to Other Courses

ZEIT3215 or in parallel with ZEIT3215

Course Learning Outcomes

Course Learning Outcomes	Engineers Australia - Professional Engineer (Stage 1)
CLO1 : Explain radar fundamentals and the parameters in range equations	• 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
CLO2 : Analyse the range and frequency resolutions of various radar systems	• 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 • PEE2.2 : Fluent application of engineering techniques, tools and resources
CLO3 : Explain the concept of RCS and backscattering characteristics of various targets;	• PEE1.1 : Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline • PEE2.2 : Fluent application of engineering techniques, tools and resources • PEE3.2 : Effective oral and written communication in professional and lay domains
CLO4 : Apply the learned concepts to radar system design and analyse trade-offs in the overall performance;	• PEE1.4 : Discernment of knowledge development and research directions within the engineering discipline • PEE2.1 : Application of established engineering methods to complex engineering problem solving • PEE2.2 : Fluent application of engineering techniques, tools and resources • PEE3.2 : Effective oral and written communication in professional and lay domains • PEE3.3 : Creative, innovative and pro-active demeanour • PEE3.4 : Professional use and management of information • PEE3.5 : Orderly management of self, and professional conduct • PEE3.6 : Effective team membership and

	team leadership
CLO5 : Perform radar image processing for error correction and image classification	• PEE1.2 : Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline • PEE2.2 : Fluent application of engineering techniques, tools and resources • PEE3.2 : Effective oral and written communication in professional and lay domains

Course Learning Outcomes	Assessment Item
CLO1 : Explain radar fundamentals and the parameters in range equations	• Laboratory Reports • Class Tests • Final Examination
CLO2 : Analyse the range and frequency resolutions of various radar systems	• Laboratory Reports • Class Tests • Final Examination
CLO3 : Explain the concept of RCS and backscattering characteristics of various targets;	• Laboratory Reports • Class Tests • Final Examination
CLO4 : Apply the learned concepts to radar system design and analyse trade-offs in the overall performance;	• Laboratory Reports • Class Tests • Final Examination
CLO5 : Perform radar image processing for error correction and image classification	• Laboratory Reports • Class Tests • Final Examination

Learning and Teaching Technologies

Moodle - Learning Management System

Learning and Teaching in this course

The delivery of course material will be primarily via lectures, which will be interspersed with worked examples. Students will utilize this knowledge in laboratory exercises on a simulator of a real radar system. This will be followed by simulation assignments, where students will gain an understanding of how all the parts of a radar system contribute to its performance, and applications in radar imaging.

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

Other Professional Outcomes

Mapping to Program Learning Outcomes

This course contributes to the following Program Learning Outcomes of the Bachelor of Engineering (Hons) (Electrical Engineering)

1. Students will be able to relate a quantitative, theory-based understanding of the sciences and fundamentals of electrical engineering (encompassing circuit analysis and design, signal processing, dynamical systems, control, power systems and communications)
2. Students will be able to appropriately select and apply the mathematical, statistical, programming and computational tools and techniques which underpin electrical engineering
5. Students will define, conduct experiments on and analyse complex, open-ended problems and apply appropriate methods for their solution.
6. Students will demonstrate proficiency in applying systematic engineering synthesis and design processes, and critically evaluating and effectively communicating the results and implications to all audiences.
7. Students will be able to operate in collaborative environments, as leader or member of interdisciplinary teams.

Outcomes-Assessment Matrix

Assessment item		LO 1	LO 2	LO 3	LO 4	LO 5
Class tests	1	X	X	X		
2			X	X	X	
Labs	Report 1	X				
Report 2			X	X		
Report 3			X	X		
Report 4					X	X
Exam		X	X	X	X	X

Additional Course Information

The delivery of course material will be primarily via lectures, which will be interspersed with worked examples. Students will utilise this knowledge in laboratory exercises on a simulator of a real radar system. This will be followed by simulation assignments, where students will gain an understanding of how all the parts of a radar system contribute to its performance, and applications in radar imaging.

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
Laboratory Reports Assessment Format: Individual	35%	
Class Tests Assessment Format: Individual	30%	
Final Examination Assessment Format: Individual	35%	Due Date: Exam week

Assessment Details

Laboratory Reports

Assessment Overview

Weekly laboratories will include simulation and measurement of radar and imaging systems.

Laboratory reports will be submitted, incorporating results from several weeks worth of labs.

Course Learning Outcomes

- CLO1 : Explain radar fundamentals and the parameters in range equations
- CLO2 : Analyse the range and frequency resolutions of various radar systems
- CLO3 : Explain the concept of RCS and backscattering characteristics of various targets;
- CLO4 : Apply the learned concepts to radar system design and analyse trade-offs in the overall performance;
- CLO5 : Perform radar image processing for error correction and image classification

Detailed Assessment Description

Lab Report 1 (5%): Lab 1 Report, Due date:11:55pm on Wednesday 13 March 2024

Lab Report 2 (10%): Labs 2 and 3 Report, Due date:11:55pm on Wednesday 27 March 2024

Lab Report 3 (10%): Labs 4 and 5 Report, Due date:11:55pm on Wednesday 8 May 2024

Lab Report 4 (10%): Labs 6 and 7 Report, Due date:11:55pm on Monday 3 June 2024

Assignment submission Turnitin type

This assignment is submitted through Turnitin and students can see Turnitin similarity reports.

Class Tests

Assessment Overview

In-class class tests during the semester.

Course Learning Outcomes

- CLO1 : Explain radar fundamentals and the parameters in range equations
- CLO2 : Analyse the range and frequency resolutions of various radar systems
- CLO3 : Explain the concept of RCS and backscattering characteristics of various targets;
- CLO4 : Apply the learned concepts to radar system design and analyse trade-offs in the overall performance;
- CLO5 : Perform radar image processing for error correction and image classification

Detailed Assessment Description

Class Test 1 (15%): Week 6

Class Test 2 (15%): Week 12

Final Examination

Assessment Overview

The Final Examination will be held during the Exam Week.

Course Learning Outcomes

- CLO1 : Explain radar fundamentals and the parameters in range equations
- CLO2 : Analyse the range and frequency resolutions of various radar systems
- CLO3 : Explain the concept of RCS and backscattering characteristics of various targets;
- CLO4 : Apply the learned concepts to radar system design and analyse trade-offs in the overall performance;
- CLO5 : Perform radar image processing for error correction and image classification

Detailed Assessment Description

2 hours, closed book, during the exam week.

Assessment Length

2 Hours

General Assessment Information

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.

Lab Report 1 will be due in Week 3. Feedback and grades will be given to students before the census date.

Late submissions:

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.

Referencing:

In line with UNSW Canberra policy, undergraduate students must be instructed to use either the APA 7 or Chicago NB (notes and bibliography) referencing conventions.
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

Use of Generative AI in Assessment:

NO ASSISTANCE! It is prohibited to use any software or service to search for or generate information or answers. If its use is detected, it will be regarded as serious academic misconduct and subject to the standard penalties, which may include 00FL, suspension, and exclusion.

Grading Basis

Standard

Requirements to pass course

The overall pass mark is 50% with the given weightings. This means students are not required to pass any one particular piece of assessment; you need to achieve at least 50 marks out of a total of 100 marks to pass this course. There is no minimum mark for any part of the course.

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 26 February - 1 March	Lecture	Introduction to Radar fundamentals and applications, Simple Pulse Radar, Radar range equation (Aboutorab)
	Tutorial	Introduction to Radar fundamentals and applications, Simple Pulse Radar, Radar range equation (Aboutorab)
Week 2 : 4 March - 8 March	Lecture	Radar detection in noise, Pulse integration, Radar Cross Section (Aboutorab)
	Tutorial	Radar detection in noise, Pulse integration, Radar Cross Section (Aboutorab)
	Laboratory	Radar fundamentals (Powell)
Week 3 : 11 March - 15 March	Lecture	Radar Antenna ((Aboutorab)) (Canberra Day Public Holiday-Monday Lecture Lost)
	Tutorial	Radar Antenna (Aboutorab)
	Laboratory	Radar range equation (Powell)
	Assessment	Lab Report 1 (5%): Lab 1 Report, Due date:11:55pm on Wednesday 13 March 2024
Week 4 : 18 March - 22 March	Lecture	CW Radar, FM-CW Radars (Aboutorab)
	Tutorial	CW and FM-CW Radar (Aboutorab)
	Laboratory	Pulse integration (Powell)
Week 5 : 25 March - 29 March	Lecture	Pulse Compression Radars (Aboutorab)
	Tutorial	Pulse Compression Radars (Aboutorab)
	Assessment	Lab Report 2 (10%): Labs 2 and 3 Report, Due date:11:55pm on Wednesday 27 March 2024
Week 6 : 1 April - 5 April	Lecture	Lecture, Pulse Doppler (Powell) (1 April-Easter Monday Public Holiday- Monday Lecture Lost)
	Laboratory	Pulse Compression Radar (Powell)
	Assessment	Class Test 1 (15%)
Week 7 : 22 April - 26 April	Lecture	Pulse Doppler Radars, MTI , Radar Tracking Techniques (Powell)
Week 8 : 29 April - 3 May	Lecture	Radar tracking techniques (Powell)
	Tutorial	Radar tracking (Powell)
	Laboratory	Radar Tracking (Powell)
Week 9 : 6 May - 10 May	Lecture	Radar remote sensing, Imaging Radar and SAR & Synthetic Aperture Radar (Qiao) Note: The Thursday tutorial is used for the lecture and the tutorial is integrated into the lecture in Weeks 9-12.
	Assessment	Lab Report 3 (10%): Lab 4 and 5 Report, Due date:11:55pm on Wednesday 8 May 2024
Week 10 : 13 May - 17 May	Lecture	Geometric properties & Scattering mechanisms (Qiao) Note: The Thursday tutorial is used for the lecture and the tutorial is integrated into the lecture in Weeks 9-12
	Laboratory	Access Images (Qiao)
Week 11 : 20 May - 24 May	Lecture	Physical content of SAR & Radar image interpretation (Qiao) Note: The Thursday tutorial is used for the lecture and the tutorial is integrated into the lecture in Weeks 9-12
	Laboratory	Process images (Qiao)
Week 12 : 27 May - 31 May	Lecture	Spaceborne SAR programs (Qiao) (Reconciliation Day Public Holiday- Monday 27 May classes delivered on Tuesday 28 May- Tuesday Lecture Lost)
	Assessment	Class Test 2 (15%)
Week 13 : 3 June - 7 June	Lecture	Revision (Aboutoral, Powell & Qiao)
	Assessment	Lab Report 4 (10%): Lab 6 and 7 Report, Due date:11:55pm on Monday 3 June 2024

Attendance Requirements

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

General Schedule Information

The provided course schedule is an indicative schedule.

Week 3: Canberra Day Public Holiday-Monday Lecture Lost

Week 6: 1 April-Easter Monday Public Holiday- Monday Lecture Lost

Week 12: Reconciliation Day Public Holiday- Monday 27 May classes delivered on Tuesday 28 May- Tuesday Lecture Lost

Course Resources

Recommended Resources

Recommended Readings:
Graham Brooker, Introduction to Sensors for Ranging and Imaging, 2009, Scitech Publishing
J.A. Richards, Remote Sensing with Imaging Radar, Springer-Verlag, Berlin, 2009
M.I. Skolnik, Introduction to Radar Systems, 3rd Ed., 2001, McGraw-Hill.
T.M. Lillesand and R.W. Kiefer, Remote Sensing and Image Interpretation, 7th Ed., 2015.

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 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
Lecturer	Neda Abouto rab		Bldg 17, 201A	0251145110	Email to book an appointment	No	No
Convenor	Lily (Li) Qiao		Bldg 16, Room 204		Email to book an appointment	Yes	Yes
Lecturer	David Powell		Building 32, Room SR102A		Email to book an appointment	No	No

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.