UNSW Course Outline

# ZEIT4007 Rotorcraft Engineering - 2024

Published on the 11 Feb 2024

## General Course Information

**Course Code :** ZEIT4007
**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

Students will be exposed to a number of topics in rotorcraft engineering. Basic helicopter configurations, such as co-axial, tandem and autogiro, are compared. Course starts with actuator disc theory and moves to more sophisticated blade element techniques for both vertical and

forward flight. Special cases include autorotation an flight in ground effect. Students are introduced to the use of dimensional analysis to reduce rotorcraft flight test data and standardise test results.Design considerations such as ground resonance, crash worthiness and fatigue safe life will also be discussed. Linearised models of helicopter dynamics are developed proceeding to useful conclusions regarding helicopter stability and flight control.

## Course Aims

The aim of this course is to expose students to a number of topics in rotorcraft engineering. Basic helicopter configurations, such as co-axial, tandem and autogiro are compared. Various rotor head designs are studied.

## Relationship to Other Courses

ZEIT1503 – Engineering Mechanics is a Prerequisite for this course.

**Assumed knowledge**

*Students should be able to perform basic calculus including differentiation and integration, apply trigonometric principles and understand scalars and vectors.*

## Course Learning Outcomes

| Course Learning Outcomes | Engineers Australia - Professional Engineer (Stage 1) |
|---|---|
| CLO1 : Compare basic helicopter configurations and rotor systems | • PEE1.3 : In-depth understanding of specialist bodies of knowledge within the engineering discipline<br>• PEE3.2 : Effective oral and written communication in professional and lay domains |
| CLO2 : Use actuator disc and blade element theories to predict helicopter performance. | • PEE1.3 : In-depth understanding of specialist bodies of knowledge within the engineering discipline<br>• PEE2.1 : Application of established engineering methods to complex engineering problem solving<br>• PEE2.2 : Fluent application of engineering techniques, tools and resources<br>• PEE3.2 : Effective oral and written communication in professional and lay domains |
| CLO3 : Describe the basic concepts of rotor aerodynamics in conditions of vertical flight, forward flight, autorotation and ground effect. | • PEE1.3 : In-depth understanding of specialist bodies of knowledge within the engineering discipline |

| Course Learning Outcomes | Assessment Item |
|---|---|
| CLO1 : Compare basic helicopter configurations and rotor systems | • Final Exam<br>• Class Test<br>• Assignment 1 |
| CLO2 : Use actuator disc and blade element theories to predict helicopter performance. | • Assignment 2<br>• Final Exam<br>• Class Test |
| CLO3 : Describe the basic concepts of rotor aerodynamics in conditions of vertical flight, forward flight, autorotation and ground effect. | • Assignment 2<br>• Final Exam |

# Learning and Teaching Technologies

Moodle - Learning Management System

# Learning and Teaching in this course

**Teaching Strategies**

The aim of lectures is to develop theoretical knowledge and demonstrate the application of the theory to problem solving through the use of worked examples in class. Four lecture hours per week are programmed. The lectures will be in a combination of face-to-face and online modes.

Tutorials sessions for the second assignment will be held to assist students with developing their helicopter numerical simulation.

**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

**Academic Integrity and Plagiarism**

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

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

**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.

# Assessments

## Assessment Structure

| Assessment Item | Weight | Relevant Dates | Engineers Australia - Professional Engineer (Stage 1) |
|---|---|---|---|
| Lab<br>Assessment<br>Format: Individual | 5% | Start Date: 30/04/2024 12:00 AM<br>Due Date: 07/05/2024 12:00 AM | • PEE1.3 : In-depth understanding of specialist bodies of knowledge within the engineering discipline<br>• PEE2.2 : Fluent application of engineering techniques, tools and resources<br>• PEE3.2 : Effective oral and written communication in professional and lay domains |
| Final Exam<br>Assessment<br>Format: Individual | 40% | | • PEE1.3 : In-depth understanding of specialist bodies of knowledge within the engineering discipline<br>• PEE2.1 : Application of established engineering methods to complex engineering problem solving<br>• PEE2.2 : Fluent application of engineering techniques, tools and resources<br>• PEE3.2 : Effective oral and written communication in professional and lay domains |
| Class Test<br>Assessment<br>Format: Individual | 15% | Start Date: 05/04/2024 01:00 PM<br>Due Date: 05/04/2024 02:45 PM | • PEE1.3 : In-depth understanding of specialist bodies of knowledge within the engineering discipline<br>• PEE2.1 : Application of established engineering methods to complex engineering problem solving<br>• PEE2.2 : Fluent application of engineering techniques, tools and resources |
| Assignment 1<br>Assessment<br>Format: Individual | 10% | Start Date: 26/02/2024 12:00 AM<br>Due Date: 16/03/2024 12:00 AM | • PEE1.3 : In-depth understanding of specialist bodies of knowledge within the engineering discipline<br>• PEE3.2 : Effective oral and written communication in professional and lay domains |
| Assignment 2<br>Assessment<br>Format: Individual | 30% | Start Date: 29/04/2024 12:00 AM<br>Due Date: 01/06/2024 12:00 | • PEE1.3 : In-depth understanding of specialist bodies of knowledge within the |

| | | | |
|---|---|---|---|
| | | AM | engineering discipline<br>• PEE2.1 : Application of established engineering methods to complex engineering problem solving<br>• PEE2.2 : Fluent application of engineering techniques, tools and resources<br>• PEE3.2 : Effective oral and written communication in professional and lay domains |

# Assessment Details

## Lab

**Assessment Overview**

n/a

**Detailed Assessment Description**

Helicopter Simulator Lab

**Assignment submission Turnitin type**

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

## Final Exam

**Assessment Overview**

n/a

**Course Learning Outcomes**

- CLO1 : Compare basic helicopter configurations and rotor systems
- CLO2 : Use actuator disc and blade element theories to predict helicopter performance.
- CLO3 : Describe the basic concepts of rotor aerodynamics in conditions of vertical flight, forward flight, autorotation and ground effect.

**Hurdle rules**

Students must pass in the final exam to pass the course.

## Class Test

**Assessment Overview**

n/a

Course Learning Outcomes

- CLO1 : Compare basic helicopter configurations and rotor systems
- CLO2 : Use actuator disc and blade element theories to predict helicopter performance.

Assignment submission Turnitin type

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

### Assignment 1

Assessment Overview

n/a

Course Learning Outcomes

- CLO1 : Compare basic helicopter configurations and rotor systems

Assessment Length

2000 words approximately

Assignment submission Turnitin type

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

### Assignment 2

Assessment Overview

n/a

Course Learning Outcomes

- CLO2 : Use actuator disc and blade element theories to predict helicopter performance.
- CLO3 : Describe the basic concepts of rotor aerodynamics in conditions of vertical flight, forward flight, autorotation and ground effect.

Assessment Length

5000 words approximately

Assignment submission Turnitin type

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

## General Assessment Information

**Assessment and feedback before census date**

Assignment 1 will be due in week 3, feedback, grades and worked solutions will be given to students during week 4

### Late Submission of Assessment

*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.*

### Use of Generative AI in Assessments

*SIMPLE EDITING ASSISTANCE*

*For assessments in this course, you may use standard editing and referencing software, but not Generative AI. You are permitted to use the full capabilities of the standard software such as Microsoft Office suite, Grammarly, etc. If the use of generative AI such as ChatGPT 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

To pass the course, student must satisfactorily meet all CLOs. Note all CLOs for this course are individually met in more than one assessment item.  In addition, students must pass in the final exam to pass the course.

### Assessment item

Assignment 1

### CLO 1

Class Test

### CLO 1 & CLO 2

Assignment 2

CLO 2 & CLO 3

Helicopter Simulator Lab

CLO 1 & CLO 3

Final Exam

CLO 1, CLO 2 & CLO 3

# Course Schedule

| Teaching Week/Module | Activity Type | Content |
|---|---|---|
| Week 1 : 26 February - 1 March | Lecture | Introduction. History of the Helicopter.<br>Lecturer: Sridhar Ravi |
| Week 2 : 4 March - 8 March | Lecture | Helicopter Configurations<br>Lecturer: Sridhar Ravi |
| Week 3 : 11 March - 15 March | Lecture | Momentum Theory<br>Lecturer: Sridhar Ravi |
| | Assessment | Assignment 1 – Essay |
| Week 4 : 18 March - 22 March | Lecture | Airfoils. Blade Element Theory. Effect of non-uniform inflow factor. Ideal Twist. Ideal Taper.<br>Lecturer: Sridhar Ravi |
| Week 5 : 25 March - 29 March | Lecture | Calculating rotor power in vertical flight. Blade tip losses.<br>Lecturer: Sridhar Ravi |
| Week 6 : 1 April - 5 April | Lecture | Introduction to forward flight. Momentum theory for forward flight. Induced velocity distributions. Hub Design.<br>Lecturer: Matt Garratt |
| | Assessment | Class Test |
| Week 7 : 22 April - 26 April | Lecture | 2nd Order Systems. Rotor flapping. Cyclic pitch and swash plates.<br><br>Lecturer: Matt Garratt |
| Week 8 : 29 April - 3 May | Lecture | Stability considerations. Reference planes.<br>Lecturer: Matt Garratt |
| Week 9 : 6 May - 10 May | Lecture | Forward Flight Performance<br>Lecturer: Matt Garratt |
| | Assessment | Helicopter Simulator Lab<br>Lab Instructor: Pete Norford |
| Week 10 : 13 May - 17 May | Lecture | Helicopter Vibration<br>Lecturer: Matt Garratt |
| Week 11 : 20 May - 24 May | Lecture | Ground effect. Autorotation<br>Lecturer: Matt Garratt |
| Week 12 : 27 May - 31 May | Lecture | Advanced Helicopter Aerodynamics. Rotor wake. Dynamic blade stall.<br>Lecturer: Matt Garratt |
| | Assessment | Assignment 2 – Project and Report |
| Week 13 : 3 June - 7 June | Lecture | Future of Rotorcraft. Revision<br>Lecturer: Matt Garratt and Sridhar Ravi |

## Attendance Requirements

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

## General Schedule Information

Week 5: 29/03 Good Friday - Lecture Lost

Week 7: 25/04 ANZAC Day - Lecture Lost

Week 9: 10/05 Military Training Day - Lecture Lost

# Course Resources

## Prescribed Resources

The compulsory textbook for this course is “Principles of Helicopter Aerodynamics,” by Gordon Leishman.

## Recommended Resources

The book “Helicopter Theory” by Wayne Johnson, Dover Books is also recommended.

## Additional Costs

None

## Course Evaluation and Development

Informal feedback from students will be sought during lectures and combined with formal feedback through MyExperience surveys will be used to improve course delivery and learning experience. Following feedback from previous year, the lab component for this course will be retained.

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 |
|---|---|---|---|---|---|---|---|
| Convenor | Sridhar Ravi | | Room 366, Building 21 | 5114 5200 | I am usually available for consultation during normal working hours. | No | Yes |
| Lecturer | Matt Garratt | | Room 371, Building 21 | 5114 5150 | I am usually available for consultation during normal working hours. Please phone or email to make 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

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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.