UNSW Course Outline

AERO3410 Aerospace Structures - 2024

Published on the 05 Feb 2024

General Course Information

Course Code : AERO3410
Year : 2024
Term : Term 1
Teaching Period : T1
Is a multi-term course? : No
Faculty : Faculty of Engineering
Academic Unit : School of Mechanical and Manufacturing Engineering
Delivery Mode : Multimodal
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

This course covers introductory and intermediate topics related to analysis and design of airframes:

Basics

- Basic flight mechanics and simple manoeuvres (to understand airframe loads) for both terrestrial and launch aerospace vehicles
- Weights and balances
- Introduction to aerostructure design and function
- Aeroelasticity (optional flex week topic)

Thin Walled Structures

- Thin-walled beam approximation
- Solid mechanics - Stress, strain, invariants
- Structural idealisation
- Bending, shear and torsion of complex beams

Aerospace Materials

- Lightweight materials - Alloys and composites
- Failure prediction
- Material degradation - Fatigue, corrosion, wear
- Analysis of composite materials

Buckling

- Buckling of columns and plates
- Stiffened panel analysis and design

Course Aims

The objectives of this course are to develop:

- an understanding the internal loads, design choices and constraints which drive the configuration of modern airframes;
- the ability to analyse aerospace structures using classical analysis techniques;
- the ability to select aerospace materials based on their fundamental properties and the functions they perform;
- the ability to design aerospace structures against failure, degradation and instability.

Relationship to Other Courses

This structures course builds on solid mechanics fundamentals developed in MMAN2400 and leads into design courses such as AERO3110 and AERO4110.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Determine internal loads in airframe components as a function of airframe layout and aircraft manoeuvres
CLO2 : Use methods for determining stress and deflections of thin walled single and multi-celled stiffened structures for axial, bending and shear loads and apply these techniques to the analysis of wing and fuselage structures in aircraft
CLO3 : Choose and justify materials to be used for specific aerospace applications based on component function, design drivers, material properties and ageing constraints
CLO4 : Predict the onset of instability of thin-walled structures under static loads and be able to recommend amendments to the structural design to avoid instability and/or improve efficiency
CLO5 : Productively contribute to a complex group engineering analysis task

Course Learning Outcomes	Assessment Item
CLO1 : Determine internal loads in airframe components as a function of airframe layout and aircraft manoeuvres	• Module Quizzes • Laboratories • Structural Analysis Project • Final Exam
CLO2 : Use methods for determining stress and deflections of thin walled single and multi-celled stiffened structures for axial, bending and shear loads and apply these techniques to the analysis of wing and fuselage structures in aircraft	• Module Quizzes • Laboratories • Structural Analysis Project • Final Exam
CLO3 : Choose and justify materials to be used for specific aerospace applications based on component function, design drivers, material properties and ageing constraints	• Module Quizzes • Structural Analysis Project • Final Exam
CLO4 : Predict the onset of instability of thin-walled structures under static loads and be able to recommend amendments to the structural design to avoid instability and/or improve efficiency	• Laboratories • Structural Analysis Project • Final Exam
CLO5 : Productively contribute to a complex group engineering analysis task	• Laboratories • Structural Analysis Project

Learning and Teaching Technologies

Moodle - Learning Management System | Microsoft Teams

Additional Course Information

A strong background in solid mechanics is assumed (equivalent to ENGG2400). This course is an application of solid mechanics principles to Aerospace structures

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Module Quizzes Assessment Format: Individual	20%	Start Date: Not Applicable Due Date: Thursday Week 4 and Thursday Week 8
Laboratories Assessment Format: Individual	20%	Start Date: Week 3 Due Date: 4pm Thursday Week 7 (28th March)
Structural Analysis Project Assessment Format: Group	30%	Start Date: Not Applicable Due Date: 4pm Friday Week 10 (19th April)
Final Exam Assessment Format: Individual	30%	Start Date: Not Applicable Due Date: Exam period

Assessment Details

Module Quizzes

Assessment Overview

2 hours each

Online quizzes teaching modules.

Mix of automatically marked questions and hand marked questions. Working will be considered for partial marks in many cases.

Course Learning Outcomes

- CLO1 : Determine internal loads in airframe components as a function of airframe layout and aircraft manoeuvres
- CLO2 : Use methods for determining stress and deflections of thin walled single and multi-celled stiffened structures for axial, bending and shear loads and apply these techniques to the analysis of wing and fuselage structures in aircraft
- CLO3 : Choose and justify materials to be used for specific aerospace applications based on component function, design drivers, material properties and ageing constraints

Assessment Length

2 hours each

Submission notes

Online Moodle Quiz

Assignment submission Turnitin type

Not Applicable

Laboratories

Assessment Overview

Two-part aerospace structures laboratory focusing on bending/torsion of beam sections representing aircraft components.

Individual submission, but lab groups may coordinate and share strategies for the more complex parts.

The format of the submission will be an engineering report of around 20 pages (actual page count updated each term based on the lab task completed).

Assessment criteria

Assessment will be judged against three criteria:

- Communication
  - Quality of English expression
  - Use of concise and unambiguous language
  - Correct presentation of data
  - High Quality formatting
- Analysis
  - Accuracy of calculations
  - Correct use of assumptions
  - Careful treatment of numerical precision
  - Robustness and flexibility of calculation tools
- Insight
  - Quality of discussion and conclusions
  - Demonstration of deeper insights gained from the analysis

Feedback will be provided via a full rubric.

Course Learning Outcomes

- CLO1 : Determine internal loads in airframe components as a function of airframe layout and aircraft manoeuvres
- CLO2 : Use methods for determining stress and deflections of thin walled single and multi-

celled stiffened structures for axial, bending and shear loads and apply these techniques to the analysis of wing and fuselage structures in aircraft
- CLO4 : Predict the onset of instability of thin-walled structures under static loads and be able to recommend amendments to the structural design to avoid instability and/or improve efficiency
- CLO5 : Productively contribute to a complex group engineering analysis task

Assessment Length

See handout

Submission notes

Moodle Submission

Assignment submission Turnitin type

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

Structural Analysis Project

Assessment Overview

Group project to analyse an airfame (5 per group). You will apply the theory learnt in lectures and workshops to a term-long project analysing and airframe.

The task will run throughout the entire term and will have a supporting 1 hour class each week. The submission format is flexible and can be chosen by the group. There is no length requirement (due to the flexible submission options) but the scope of the work is equivalent to a 50 page engineering report.

Assessment criteria

The marking for this assessment is completed in two stages:

1. The assignment will have one single group grade applied. You will see this grade and comments.
2. The group grade will be moderated based on claimed contributions and demonstrator evaluations. You will receive an **individual** grade.

A detailed marking rubric for this assessment will be provided.

Course Learning Outcomes

- CLO1 : Determine internal loads in airframe components as a function of airframe layout and

aircraft manoeuvres
- CLO2 : Use methods for determining stress and deflections of thin walled single and multi-celled stiffened structures for axial, bending and shear loads and apply these techniques to the analysis of wing and fuselage structures in aircraft
- CLO3 : Choose and justify materials to be used for specific aerospace applications based on component function, design drivers, material properties and ageing constraints
- CLO4 : Predict the onset of instability of thin-walled structures under static loads and be able to recommend amendments to the structural design to avoid instability and/or improve efficiency
- CLO5 : Productively contribute to a complex group engineering analysis task

Assignment submission Turnitin type

Not Applicable

Final Exam

Assessment Overview

Assessment length: 2 hours

The exam will be completed in the computer labs during the usual exam period.

Course Learning Outcomes

- CLO1 : Determine internal loads in airframe components as a function of airframe layout and aircraft manoeuvres
- CLO2 : Use methods for determining stress and deflections of thin walled single and multi-celled stiffened structures for axial, bending and shear loads and apply these techniques to the analysis of wing and fuselage structures in aircraft
- CLO3 : Choose and justify materials to be used for specific aerospace applications based on component function, design drivers, material properties and ageing constraints
- CLO4 : Predict the onset of instability of thin-walled structures under static loads and be able to recommend amendments to the structural design to avoid instability and/or improve efficiency

Assessment Length

2.5 hours

Assessment information

The exam will be completed in the computer labs during the usual exam period.

Assignment submission Turnitin type

Not Applicable

General Assessment Information

Grading Basis

Standard

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 12 February - 18 February	Online Activity	Get set up • Join the MS Team • Visit the course home page (which will have links for all this stuff) • MATLAB Create your Mathworks account (if you don't have one already) Get MATLAB on your device (free download or use online version) Do the free 2 hour Onramp course on Mathworks
	Lecture	Basics - Aircraft Mechanics • Aircraft equilibrium • Load factor • Simple manoeuvres • Weights and balances Basics - Airframe Anatomy • Airframe nomenclature • Internal airframe loads • Aerostructure design philosophy • Introduction to aerospace materials
Week 2 : 19 February - 25 February	Lecture	Structures - Airframe Internal Loads • Estimating Shear Force and Bending Moments in aircraft sections • Inertial loads • Launch vehicle example Structures - Mechanics of Solids • Stress and strain tensors • Plane stress • Tensor invariants • Strain gauges • Elasticity • Transformation of stress/strain and stiffness • Stress in orthotropic materials
Week 3 : 26 February - 3 March	Lecture	Structures - Bending of Thin-walled Sections • Moments of Area • Shear Force and Bending Moments • Thin-walled Approximation • Unsymmetrical Bending Structures - Shear and Torsion of Thin-walled Sections • Shear flow • Torsion of open and closed sections • Shear of open and closed sections • Shear centre
	Laboratory	Beam Bending and Torsion Lab See timetable for timeslot
Week 4 : 4 March - 10 March	Lecture	Structures - Shear and Torsion of Thin-walled Sections (Continued) Structures - Idealisation of Thin-walled Sections • Further thin-walled approximations and simplifications • Boom and panel analysis • Bending, shear and torsion loads on idealised structures
Week 5 : 11 March - 17 March	Lecture	Structures - Complex Thin-walled Sections • Combined open-closed sections • Sections with multiple cells • Bending, shear and torsion loads applied to complex sections Materials - Properties and Lifetimes • Strength • Fracture toughness • Fatigue life estimation
	Laboratory	Wing Bending and Torsion Laboratory See timetable for timeslot
Week 6 : 18 March - 24 March	Lecture	Aeroelasticity (Bonus Lecture) • Divergence • Control reversal • Flutter Note: Aeroelasticity is an important phenomena for aircraft structures, but it doesn't fit well anywhere else in the course. This is a bonus lecture in flex week. None of the material in this lecture will be assessed.
Week 7 : 25 March - 31 March	Lecture	Materials - Composite Mechanics • Drivers for composites use in airframes • Composite manufacturing • Properties • Laminates and effective engineering properties

		No Friday lecture due to Easter break
Week 8 : 1 April - 7 April	Lecture	No lecture due to Easter break
Week 9 : 8 April - 14 April	Lecture	Buckling - Shells and Columns • Column buckling recap • Shell buckling • Buckling under shear • Buckling of curved panels
Week 10 : 15 April - 21 April	Lecture	Buckling - Stiffened Panels • Modes of stiffened panel buckling • Crippling • Limit and ultimate load cases

Attendance Requirements

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

General Schedule Information

Lectures

Monday 12-2pm - Ainsworth 202*

Friday 11am-1pm - Ainsworth G02*

* both classes will transition to Digital Teaching Studio (level 5 Ainsworth) is the class numbers allow

Workshops

Wednesday 11am-1pm - Ainsworth 202

Project Class

Tuesday 1-2pm - Mathews 103

Course Resources

Prescribed Resources

Microsoft Teams

Microsoft's communication platform, Microsoft Teams, will be used extensively in this course. It has native apps for Windows, Android, iOS and more.

myAccess and Matlab

UNSW myAccess provides access to your engineering software from many different devices. This course will use Matlab extensively, which is available through myAccess and the computer labs.

Moodle

The Moodle LMS, https://moodle.telt.unsw.edu.au/ will also be used for this course for activities and gradebook management. You will not need to regularly check Moodle.

Required Textbook

Megson, T.H.G. Aircraft Structures for Engineering Students, Sixth Edition. Elsevier 2012. (4th and 5th editions will suffice with minor inconvenience)

Recommended Resources

Suggested Textbook

- Flabel, J.C. Practical Stress Analysis for Design Engineers. Lake City Publishing Company, 1997.

Recommended Reading

- Cutler, J. Understanding Aircraft Structures, Fourth Edition. Blackwell, 2005.
- Daniel, I.M. and Ishai, O. Engineering Mechanics of Composite Materials. Oxford University Press, 1994.
- Niu, M.C.Y. Airframe Structural Design. Conmilit Press, 1988.
- Niu, M.C.Y. Composite Airframe Structures. Conmilit Press, 1992.
- Baker A., Dutton S. and Kelly, D. Composite Materials for Aircraft Structures, 2nd Edition. AIAA Education Series, 2004.

Course Evaluation and Development

Feedback on the course is gathered periodically using various means, including the UNSW myExperience process, informal discussion in the final class for the course, and the School's Student/Staff meetings. Your feedback is taken seriously, and continual improvements are made to the course based, in part, on such feedback.

For 2024, the improvements and changes are:

- Resequencing the course to make more time for assessment completion
- Simplification of lab requirements and addition of class teaching to better support calculations

- Better tracking and recognition of individual performance in group assignment

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Garth Pearce		Teams, Ainsworth 208E	Teams call	Monday 2-3pm (After lecture)	No	Yes

Other Useful Information

Academic Information

I. Special consideration and supplementary assessment

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to, or within 3 working days of, submitting an assessment or sitting an exam.

Please note that UNSW has a Fit to Sit rule, which means that if you sit an exam, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

II. Administrative matters and links

All students are expected to read and be familiar with UNSW guidelines and polices. In particular, students should be familiar with the following:

- Attendance
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Equitable Learning Services

III. Equity and diversity

Those students who have a disability that requires some adjustment in their teaching or learning

environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equitable Learning Services. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

IV. Professional Outcomes and Program Design

Students are able to review the relevant professional outcomes and program designs for their streams by going to the following link: https://www.unsw.edu.au/engineering/student-life/student-resources/program-design.

Note: This course outline sets out the description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle or your primary learning management system (LMS) should be consulted for the up-to-date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline/Moodle/LMS, the description in the Course Outline/Moodle/LMS applies.

Academic Honesty and Plagarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism, visit: student.unsw.edu.au/plagiarism. The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis or contract cheating) even suspension from the university. The Student Misconduct Procedures are available here:

www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Submission of Assessment Tasks

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of five percent (5%) of the maximum mark possible for that assessment item, per calendar day.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day. This is for all assessments where a penalty applies.

Work submitted after five days (120 hours) will not be accepted and a mark of zero will be awarded for that assessment item.

For some assessment items, a late penalty may not be appropriate. These will be clearly indicated in the course outline, and such assessments will receive a mark of zero if not completed by the specified date. Examples include:

- Weekly online tests or laboratory work worth a small proportion of the subject mark;
- Exams, peer feedback and team evaluation surveys;
- Online quizzes where answers are released to students on completion;
- Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date; and,
- Pass/Fail assessment tasks.

Faculty-specific Information

Engineering Student Support Services – The Nucleus - enrolment, progression checks, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries e.g. admissions, fees, programs, credit transfer

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

School-specific Information

Short Extensions

Short extensions are not currently applicable to Mechanical and Manufacturing Engineering Courses.

Review of Results

The purpose of a review of results is if there was a marking error. Review of results is for when you have cause to believe that there is a marking error. Review of Results cannot be used to get feedback. If you would like feedback for assessments prior to the final exam, you are welcome to contact the course convenor directly. No feedback will be provided on final exams.

Use of AI

The use of AI is prohibited unless explicitly permitted by the course convenor. Please respect this and be aware that penalties will apply when unauthorised use is detected, such as through Turnitin. If the use of generative AI, such as ChatGPT, is allowed in a specific assessment, they must be properly credited, and your submissions must be substantially your own work.

School Contact Information

Location

UNSW Mechanical and Manufacturing Engineering

Ainsworth building J17, Level 1

Above Coffee on Campus

Hours

9:00–5:00pm, Monday–Friday*

*Closed on public holidays, School scheduled events and University Shutdown

Web

School of Mechanical and Manufacturing Engineering

Engineering Student Support Services

Engineering Industrial Training

UNSW Study Abroad and Exchange (for inbound students)

UNSW Future Students

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

(+61 2) 9385 4097 – School Office**

**Please note that the School Office will not know when/if your course convenor is on campus or available

Email

Engineering Student Support Services – current student enquiries

- e.g. enrolment, progression, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries

- e.g. admissions, fees, programs, credit transfer

School Office – School general office administration enquiries

- NB: the relevant teams listed above must be contacted for all student enquiries. The School will only be able to refer students on to the relevant team if contacted

Important Links

- Student Wellbeing
- Urgent Mental Health & Support
- Equitable Learning Services
- Faculty Transitional Arrangements for COVID-19
- Moodle
- Lab Access
- Computing Facilities
- Student Resources
- Course Outlines
- Makerspace
- UNSW Timetable
- UNSW Handbook