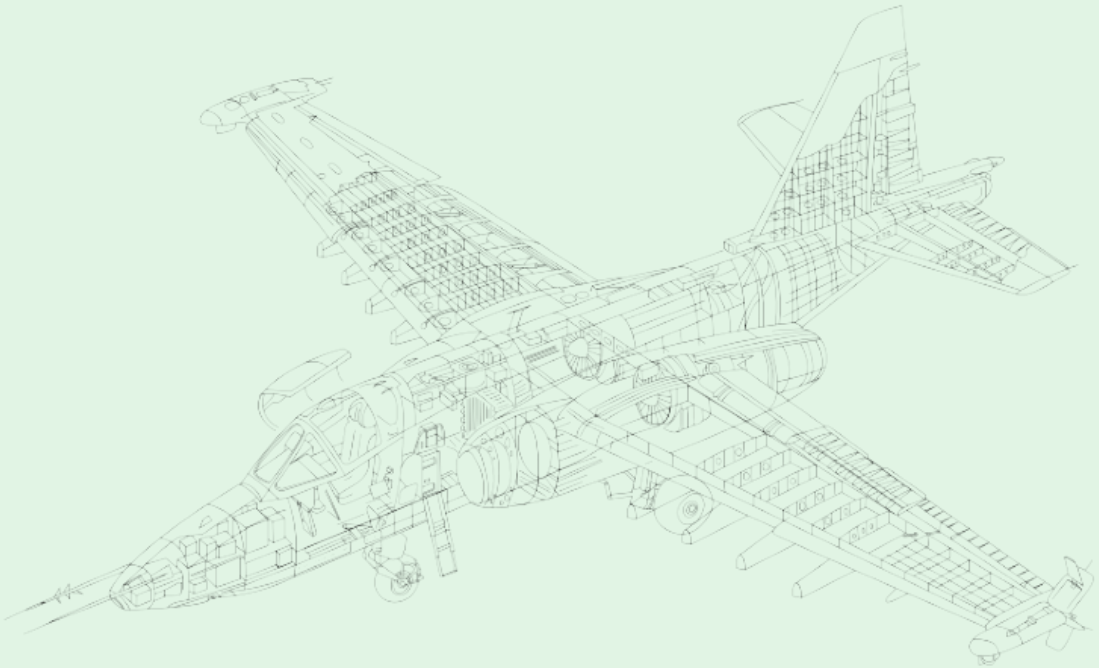
AERO3410

Aerospace Structures

Term 1, 2022



Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Garth Pearce	g.pearce@unsw.edu.au	Monday 1-2pm (After lecture via Teams)	Teams, Ainsworth 208E	Teams call

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

Course Details

Units of Credit 6

Summary of the Course

The course features three sequential modules:

- **Aerospace Materials and their Properties**: This module introduces the materials that aerospace structures are constructed from: primarily aluminium alloys and composites. The performance of these materials will be assessed relative to the important design drivers for aircraft structures.
- **Analysis of Thin-walled Structures**: This module gives you the capability to analyse simple airframe structures and develops an intuitive understanding of why aircraft structures have evolved into the current configurations. The lectures and supporting material introduce bending, shear, torsion and deflection of open and closed thin-walled beams and multi-cell structures. The methods developed are applied to the analysis of the fuselage, fuselage frames, wings and wing ribs.
- **Structural Instability and Aeroelasticity**: Many structural components are designed to meet criteria other than strength. Buckling, for instance, is instability in the response of thin walled stiffened panels under compression which relates to instability of the geometry of structure. Aeroelasticity is a relationship between the stiffness, mass and aerodynamic forces generated by a wing, which can lead to catastrophic structural failure. This module will cover the advanced analysis methods for structural instability and aeroelasticity; which provide additional design constraints over and above structural strength requirements.

Course Aims

The objectives of this course are to develop:

- an understanding of the configuration and materials used in the airframe;
- the ability to analyse aerospace structures using classical analysis techniques;
- the ability to design aerospace structures against failure, degradation, instability and aeroelasticity.

Course Learning Outcomes

After successfully completing this course, you should be able to:

Learning Outcome	EA Stage 1 Competencies
1. Choose and justify materials to be used for specific aerospace applications based on component function, design drivers, material properties and ageing constraints	PE1.3, PE1.5, PE2.1
2. 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	PE1.3, PE2.1

Learning Outcome	EA Stage 1 Competencies
3. Predict the onset of instability of thin-walled structures under static, dynamic and aeroelastic loads and be able to recommend amendments to the structural design to avoid instability and/or improve efficiency	PE1.5, PE2.2

Teaching Strategies

The approach to teaching in this class is shaped by a range of formal and informal best-practice methods. The objective, when at all possible, is for you to experience concepts using multiple deliver modes (theory, example problems, simulations, demonstrations, projects, etc.).

Six different approaches will be coordinated to deliver the course learning outcomes:

- **Lectures**: Lecture materials will cover the core course content. Lectures will be delivered in both face-to-face and online format. The lectures will feature some worked examples of problems.
- **Class Discussion**: Interaction with lecturers, demonstrators and peers in a structured class discussion is an excellent way to test and extend your understanding.
- **Demonstrations**: Demonstration questions let you apply the lessons learnt in class. Discussing the obstacles you faced in the questions with a demonstrator allows you to grasp the key tools that you will need to address future problems.
- **Solving Problems with Code**: Coding is an indispensable tool for all engineers. Using code helps you to abstract problems and solve them algorithmically. In this course, MATLAB examples will be used to demonstrate how to solve whole classes of problems, rather than specific instances.
- **Laboratory Demonstrations**: Laboratory demonstrations of some core concepts will be provided. Laboratories allow you to physically experience the theoretical concepts taught in class.
- **Assignments** (with group work): Assignments allow you to apply your new skills to challenging tasks that may involve synthesis of multiple concurrent conceptual approaches. Group work, peer feedback and self-reflection on submissions will develop critical professional skills.

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

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Module Quizzes	20%	See info below	1, 2
2. Laboratories	20%	5pm Friday Week 8	2
3. Structural Analysis Project	30%	5pm Friday Wk 10	1, 2, 3
4. Final Exam	30%	Exam period	1, 2, 3

Assessment 1: Module Quizzes

Assessment length: 2 hours each
Due date: See info below
Deadline for absolute fail: N/A

Two online quizzes for the first two teaching modules

Additional details

A quiz for each Module:

- Quiz 1: Thursday Wk 3
- Quiz 2: Thursday Wk 7

Assessment 2: Laboratories

Assessment length: See handout
Submission notes: Moodle Submission
Due date: 5pm Friday Week 8
Deadline for absolute fail: 4 days after due date
Marks returned: 2 weeks after deadline

Two-part aerospace structures laboratory:

- Excercise and demo video handed out early in term
- Optional in-person labs during flex week
- Group submission (groups of 4)

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

A full rubric will be provided in Teams.

Assessment 3: Structural Analysis Project

Due date: 5pm Friday Wk 10
Deadline for absolute fail: 4 days after due date
Marks returned: Two weeks after deadline

Group project to analyse airfame (groups of 4)

Assessment criteria

The assignment will have one single group grade applied, which will be moderated based on individual peer and demonstrator evaluations. Each student will receive an individual grade.

Assessment 4: Final Exam

Assessment length: 2 hours
Due date: Exam period

Final Exam

Attendance Requirements

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

Course Schedule

Lectures: Monday 11am - 1pm (Online via Teams)

Demonstration Workshops: Tuesday 11am - 1pm (Ainsworth 202 and Online via Teams)

Project Workshops: Tuesday 2 - 3pm (Online via Teams)

View class timetable

Timetable

Date	Type	Content
O-Week: 7 February - 11 February	Online Activity	**Introduction to Airframes** Online activity to get you excited for the course. • Flight loads • Why do we need an airframe? • Airframe anatomy • Airframe design history and strategies
Week 1: 14 February - 18 February	Lecture	**Aerospace Materials** • Drivers for airframe material selection • Aircraft ageing: Fatigue, Corrosion, Wear, Creep
Week 2: 21 February - 25 February	Lecture	**Solid Mechanics (Refresher)** • Elasticity • Stress and strain tensors • Invariants and failure prediction • Material characterisation
	Lecture	**Composites** • Fibre reinforced materials • Properties of composites • Characterisation • Laminates • Failure prediction
Week 3: 28 February - 4 March	Lecture	**Thin-walled Beams (Bending)**

		• Beam View of Aircraft Structures • Moments of Area • Shear Force and Bending Moments • Thin-walled Approximation • Unsymmetrical Bending
	Assessment	**Quiz 1** Quiz 1 covers material from the course introduction and Module 1: • Airframe basics • Aerospace materials • Solid mechanics • Composites **Quiz 1 will be online on Thursday Week 3.**
Week 4: 7 March - 11 March	Lecture	**Thin-walled Beams (Shear and Torsion)** • Shear flow • Torsion of open and closed sections • Shear of open and closed sections • Shear centre
Week 5: 14 March - 18 March	Lecture	**Structural Idealisation** • Further simplification of thin-walled structures • Bending, shear and torsion loads on idealised structures
Week 6: 21 March - 25 March	Tut-Lab	**Optional Lab Demonstrations** Optional lab demos will be offered during Week 6. Scheduling will be completed online.
Week 7: 28 March - 1 April	Lecture	**Complex Thin-walled Structures** • Combined open-closed sections • Sections with multiple cells • Built-up beams
	Assessment	**Quiz 2** Quiz 2 covers material from Module 2: • Bending, shear and torsion of thin-walled beams

		• Structural idealisation • Complex thin-walled structures **Quiz 2 will be online on Thursday Week 7.**
Week 8: 4 April - 8 April	Lecture	**Buckling** • Buckling of columns and shells
Week 9: 11 April - 15 April	Lecture	**Stiffened Panel Buckling** • Modes of stiffened panel buckling • Crippling • Limit and ultimate load cases • Buckling under shear • Buckling of curved panels
Week 10: 18 April - 22 April	Lecture	**Aeroelasticity** • Divergence • Control reversal • Flutter

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.

In this course, recent improvements resulting from student feedback include

- One extra hour of demonstration each week
- Demonstrations run by the course convenor with inclusion of more MATLAB instruction
- More worked solutions for tutorial problems
- More time for quizzes
- Overall reduction in the complexity of the end-of-term assessment without compromising the learning opportunity

Laboratory Workshop Information

Laboratory scheduling and training will be provided on Teams.

Submission of Assessment Tasks

Assessment submission and marking criteria

Should the course have any non-electronic assessment submission, these should have a standard School cover sheet.

All submissions are expected to be neat and clearly set out. Your results are the pinnacle of all your hard work and should be treated with due respect. Presenting results clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect.

Marking guidelines for assignment submissions will be provided at the same time as assignment details to assist with meeting assessable requirements. Submissions will be marked according to the marking guidelines provided.

Late policy

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of 20 percent (20%) of the maximum mark possible for that assessment item, per calendar day, for a minimum of zero marks.

The late penalty is applied per calendar day (or part thereof), including weekends and public holidays, that the assessment is overdue.

Work submitted after the ‘deadline for absolute fail’ is not accepted and a mark of zero will be awarded for that assessment item. For example:

- Your course has an assessment task worth a total of **30 marks (Max Possible Mark)**
- You submit the assessment **2 days after the due date**
- The assessment is marked as usual and achieves a score of **20 marks (Awarded Mark)**
- The late policy is applied using **Late Mark = Awarded Mark - (Days*Penalty per Day)*Max Possible Mark**. Your adjusted final score is **8 marks** (20 - ((2*0.2)*30)).

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

1. Weekly online tests or laboratory work worth a small proportion of the subject mark, or
2. Online quizzes where answers are released to students on completion, or
3. Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date, or
4. Pass/Fail assessment tasks.

Examinations

You must be available for all quizzes, tests and examinations. For courses that have final examinations, these are held during the University examination periods: February for Summer Term, May for T1, August for T2, and November/December for T3.

Please visit myUNSW for Provisional Examination timetable publish dates. For further information on

exams, please see the Exams webpage.

Special Consideration

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 submitting an assessment or sitting an exam.

UNSW now has a Fit to Sit / Submit rule, which means that if you attempt an exam or submit a piece of assessment, 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.

Please note that students will **not** be required to provide **any** documentary evidence to support absences from any classes missed **because of COVID-19 public health measures such as isolation**. UNSW will **not** be insisting on medical certificates from anyone deemed to be a positive case, or when they have recovered. Such certificates are difficult to obtain and put an unnecessary strain on students and medical staff.

Applications for special consideration **will** be required for assessment and participation absences – but no documentary evidence **for COVID-19 illness or isolation** will be required.

Special Consideration Outcomes

Assessments have default Special Consideration outcomes. The default outcome for the assessment will be advised when you apply for Special Consideration. Below is the list of possible outcomes:

Outcome	Explanation	Example
Time extension	Student provided more time to submit the assessment	e.g. 1 more week of time granted to submit a report
Supplementary assessment	Student provided an alternate assessment at a later date/time	e.g. a supplementary exam is scheduled during the supplementary exam period of the term
Substitute item	The mark for the missed assessment is substituted with the mark of another assessment	e.g. mark for Quiz 1 applied also applied as mark for Quiz 2, meaning if a student achieved a mark of 20/30 for Quiz 1 and was granted Special Consideration for Quiz 2, a mark of 20/30 would be applied for Quiz 2, etc
Exemption	All course marks are recalculated excluding this assessment and its weighting	e.g. The course has an assessment structure of: - Assignments 30%, - Lab report 30%, - Final Exam 40%. If the Lab report is missed and student is granted Special Consideration, then the assessment structure may be reweighted as follows: - Assignments 50% - Final Exam 50% as though the Lab report did not exist
Non-standard	Course Coordinator is contacted for the outcome when special consideration is granted as the outcome differs on a case-by-case basis	e.g. typical for group assessments where time extension supplementary assessment could be granted to the group member, time extension could be granted to the whole group, etc. Clarify with your Course Convenor for

Academic Honesty and Plagiarism

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.

If plagiarism is found in your work when you are in first year, your lecturer will offer you assistance to improve your academic skills. They may ask you to look at some online resources, attend the Learning Centre, or sometimes resubmit your work with the problem fixed. However more serious instances in first year, such as stealing another student's work or paying someone to do your work, may be investigated under the Student Misconduct Procedures.

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) even suspension from the university. The Student Misconduct Procedures are available here:

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

Academic Information

Credit points

Course credit is calculated in Units-Of-Credit (UOC). The normal workload expectation for one UOC is approximately 25 hours per term. This includes class contact hours, private study, other learning activities, preparation and time spent on all assessable work.

Most coursework courses at UNSW are 6 UOC and involve an estimated 150 hours to complete, for both regular and intensive terms. Each course includes a prescribed number of hours per week (h/w) of scheduled face-to-face and/or online contact. Any additional time beyond the prescribed contact hours should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

On-campus class attendance

****T1-2022 UPDATE****
- -

Public distancing conditions must be followed for all face-to-face classes. To ensure this, only students enrolled in those classes will be allowed in the room. No over-enrolment is allowed in face-to-face classes. Students enrolled in online classes can swap their enrolment from online to on-campus classes by Sunday, Week 1. Please refer to your course's Microsoft Teams and Moodle sites for more information about class attendance for in-person and online class sections/activities.

Your health and the health of those in your class is critically important. You must stay at home if you are sick or have been advised to self-isolate by NSW health or government authorities. Current alerts and a list of hotspots can be found here. **You will not be penalised for missing a face-to-face activity due to illness or a requirement to self-isolate.** We will work with you to ensure continuity of learning during your isolation and have plans in place for you to catch up on any content or learning activities you may miss. Where this might not be possible, an application for fee remission may be discussed. Further information is available on any course Moodle or Teams site.

In certain classroom and laboratory situations where physical distancing cannot be maintained or there is a high risk that it cannot be maintained, face masks will be considered **mandatory PPE** for students and staff.

For more information, please refer to the
FAQs: https://www.covid-19.unsw.edu.au/safe-return-campus-faqs

Guidelines

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

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CRICOS

CRICOS Provider Code: 00098G

Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	✓
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	✓
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering problem solving	✓
PE2.2 Fluent application of engineering techniques, tools and resources	✓
PE2.3 Application of systematic engineering synthesis and design processes	
PE2.4 Application of systematic approaches to the conduct and management of engineering projects	
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	
PE3.2 Effective oral and written communication in professional and lay domains	
PE3.3 Creative, innovative and pro-active demeanour	
PE3.4 Professional use and management of information	
PE3.5 Orderly management of self, and professional conduct	
PE3.6 Effective team membership and team leadership	