UNSW SYDNEY | Australia's Global University

Mechanical and Manufacturing Engineering

Course Outline

Term 1 2020

AERO3410

AEROSPACE STRUCTURES

Contents

1. Staff contact details

Contact details and consultation times for course convenor

Name:	Garth Pearce
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Moodle:	https://moodle.telt.unsw.edu.au/course/view.php?id=38425

If you require consultation for this course, please use the following hierarchy. It provides the most benefit to entire class if questions can be answered in a public setting.

1. Ask the question in class
2. Use the AERO3410 Microsoft Teams discussion forum. You can direct questions to individual demonstrators using @handles.
3. Arrange a consultation with the course convenor via Teams or email.

Dedicated consultation time: Monday 12-1pm (after lecture)

Contact details and consultation times for additional lecturers/demonstrators/lab staff

Demonstrators can be contacted directly using @handles in Teams:

- Congyuan Tao
- Joshua Townsend
- Daniel Wong

2. Important links

- Moodle
- Lab Access
- Health and Safety
- Computing Facilities
- Student Resources
- Course Outlines
- Engineering Student Support Services Centre
- Makerspace
- UNSW Timetable
- UNSW Handbook
- UNSW Mechanical and Manufacturing Engineering

3. Course details

Credit points

This is a 6 unit-of-credit (UoC) course. The normal workload expectations of a student are approximately 25 hours per term for each UOC, including class contact hours, other learning

activities, preparation and time spent on all assessable work.

This course involves 5 hours per week (h/w) of face-to-face contact. You should aim to spend about 12 h/w on this course. The additional time should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

Contact hours

	Day	**Time**	**Location**
Lectures	Monday	10am-12pm	Ainsworth 202
Demonstrations	Thursday	10am-12pm	Ainsworth 202
	Wednesday	5-6pm	Mathews 103
Lab	Thursday and Friday	Week 5 and 7/8 See your timetable.	UTL

Please refer to your class timetable for the learning activities you are enrolled in and attend only those classes.

****Note:** Friday Week 8 labs have been moved to Friday Week 7 to avoid the public holiday. **Please ignore your timetable for the second lab!**

Summary and Aims of the course

This course is broken into three modules which will be taught in series:

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.

The aims of this course are to develop:

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

Student learning outcomes

This course is designed to address the learning outcomes below and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers as shown. The full list of Stage 1 Competency Standards may be found in Appendix A.

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

Learning Outcome		**EA Stage 1 Competencies**
1.	decide upon materials to be used for specific aerospace applications based on component function, design drivers, material properties and ageing constraints	1.3, 1.5, 2.1
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	1.3, 2.1
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	1.5, 2.2

4. 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.

5. Course schedule

Week	***Mod***	***Topic***	***Concepts***	***Suggested Readings***
1	N/A	Airframe Basics	Flight Loads, Loads on the Airframe, Load Paths, Role of Components, Airframe types, Stressed Skin Design	*Megson B1-2*
2	1	Aerospace Materials	Drivers for Airframe Materials, Beneficial Properties, Choice of Materials, Fatigue, Corrosion, Wear, Creep	*Megson A1,B1*
Online		Solid Mechanics	Elasticity, Stress and Strain Tensor, Invariants and Failure Prediction, Material Characterisation	
3		Composites	Fibre Reinforced Materials, Properties, Characterisation, Laminates, Classical Laminate Theory, Failure Prediction	
4	2	Thin-walled Beams (Bending)	Beam View of Aircraft Structures, Shear Force and Bending Moments, Thin-walled Approx., Moments of Area, Unsymmetrical Bending	*Megson B3-4*
5		Thin-walled Beams (Shear and Torsion)	Shear Flow, Torque Diagrams, Torsion of Open and Closed Closed Sections, Shear of Open and Closed Sections, Shear Centre	
6		Structural Idealisation	Bending, Shear, Torsion	
7		Complex Thin-walled Structures	Combined Open-Closed, Multiple Box, Built-up-Beams	
8	3	Buckling	Columns, Shells	*Megson A4, B6 Flabel*
9		Stiffened Panel Buckling	Modes of Buckling, Crippling, Limit and Ultimate Buckling, Shear Buckling, Curved Panel Buckling	
10		Aeroelasticity	Divergence, Control Reversal, Flutter	

6. Assessment

Assessment overview

Assessment	Group Project? (# Students per group)	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
Block Quizzes (2)	No	2 x 2 hours	2 x 10%	1,2	Correct answer, Correct working, Logical approach	1: Midnight Thurs Wk 4 2: Midnight Thurs Wk 8	N/A	After quiz closes for all students
Lab Reports (2)	1: No 2: Yes (4)	No page limit*	2 x 10%	1,2	Report writing and effective communication, technical calculations	1: 5pm Friday Wk 6 2: 5pm Friday Wk 10	4 days after due date	2 weeks after submission
Group Structural Analysis Project	Yes (4)	N/A**	20%	1,2,3	TBD by class	Midnight Tuesday Wk 11	4 days after due date	2 weeks after submission
Final Exam	No	TBD	40%	1,2,3	Correct answer, Correct working, Logical approach	Exam period	N/A	Upon release of final results

* No page limit but brevity is key. You will be judged on your ability to produce a concise, efficient report. Assess the usefulness of each and every paragraph, table and figure.

** The submission format for the group report will be non-traditional (i.e. via a Sharepoint site). This will be discussed during term.

Assignments

Presentation

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.

Submission

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.

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.

Work submitted after the 'deadline for absolute fail' is not 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 are clearly indicated in the course outline, and such assessments receive a mark of zero if not completed by the specified date. Examples include:

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

Marking

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.

Examinations

You must be available for all tests and examinations. There will be two online quizzes for the course which will need to be completed within a time window on Thursday weeks 4 and 8 respectively.

The final examination will occur during the university examination period in May. Please visit myUNSW for Provisional Examination timetable publish dates.

For further information on exams, please see the Exams webpage.

Calculators

You will need to provide your own calculator of a make and model approved by UNSW for the examinations. The list of approved calculators is available at student.unsw.edu.au/exam-approved-calculators-and-computers

It is your responsibility to ensure that your calculator is of an approved make and model, and to obtain an "Approved" sticker for it from the Engineering Student Supper Services Centre prior to the examination. Calculators not bearing an "Approved" sticker will not be allowed into the examination room.

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 submitting an assessment or sitting an exam.

Please note that UNSW now has a Fit to Sit / Submit rule, which means that if you sit 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.

7. Expected resources for students

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.

Learning Management System

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.

Textbooks

Required Textbook

- Megson, T.H.G. *Aircraft Structures for Engineering Students,* Fifth Edition. Elsevier

2012. (4th Edition will suffice with minor inconvenience)

Recommended Background Knowledge

- Cutler, J. Understanding Aircraft Structures, Fourth Edition. Blackwell, 2005.

Suggested Textbooks

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

Recommended Reading

- 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.

UNSW Library website: https://www.library.unsw.edu.au/
Moodle: https://moodle.telt.unsw.edu.au/login/index.php

8. 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 time for quizzes
- Formalisation of lab timetable and moving assessment earlier in the term
- Overall reduction in the complexity of the end-of-term assessment without compromising the learning opportunity

9. 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

10. 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

Appendix A: Engineers Australia (EA) Competencies

Stage 1 Competencies for Professional Engineers

	Program Intended Learning Outcomes
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing
	PE1.3 In-depth understanding of specialist bodies of knowledge
	PE1.4 Discernment of knowledge development and research directions
	PE1.5 Knowledge of engineering design practice
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice
PE2: Engineering Application Ability	PE2.1 Application of established engineering methods to complex 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
PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability
	PE3.2 Effective oral and written communication (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