UNSW SYDNEY | Australia's Global University

Mechanical and Manufacturing Engineering

Course Outline

Semester 1 2018

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=32559

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: Tuesdays 10-11am (before tutorial class)

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

Please see the course Moodle.

2. Important links

- Moodle
- UNSW Mechanical and Manufacturing Engineering
- Course Outlines
- Student intranet
- UNSW Mechanical and Manufacturing Engineering Facebook
- UNSW Handbook

3. Course details

Credit Points

This is a 6 unit-of-credit (UoC) course, and involves 4 hours per week (h/w) of face-to-face contact.

The UNSW website states “The normal workload expectations of a student are approximately 25 hours per semester for each UoC, including class contact hours, other learning activities, preparation and time spent on all assessable work. Thus, for a full-time enrolled student, the normal workload, averaged across the 16 weeks of teaching, study and examination periods, is about 37.5 hours per week.”

This means that you should aim to spend about 9 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	Wednesday	10am - 12pm	Ainsworth 202
Demonstrations	Tuesday	11am – 1pm	Mathews 103
Lab	TBA		

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

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.

There will be two hours of interactive demonstrations a week to cover example problems from all modules and to undertake a semester long project. Two laboratories will be available on a flexible timeframe to assist with your understanding of unsymmetrical beams loaded in bending and shear.

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 conceptual grasp of the course materials and the depth of 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.
- *Adaptive Tutorials:* A selection of adaptive tutorials will be provided which cover key topics in the course. Each example is a self-paced exercise with highly directed feedback specific to your individual responses to the question. The adaptive demonstrations provide many of the advantages of a tutor but can be accessed at any time of day or night.
- *Laboratory Demonstrations:* Laboratory demonstrations of some core concepts will be provided. Laboratories allow you to physically experience the theoretical concepts

taught in class. These labs are entirely optional and area available for access outside of normal class hours.

- *Assignments (with Peer Feedback):* Assignments allow you to apply your new skills to challenging tasks that may involve synthesis of multiple concurrent conceptual approaches. Peer feedback and self-reflection on submissions will develop critical professional skills.

5. Course schedule

Date	***Week***	***Mod***	***Topic***	***Concepts***	***Suggested Readings***
28 Feb	*1*	N/A	Airframe Basics	Flight Loads, Loads on the Airframe, Load Paths, Role of Components, Airframe types, Stressed Skin Design	*Megson B1-2*
07 Mar	*2*	1	Aerospace Materials	Drivers for Airframe Materials, Beneficial Properties, Choice of Materials, Fatigue, Corrosion, Wear, Creep	*Megson A1,B1*
14 Mar	*3*		Solid Mechanics	Elasticity, Stress and Strain Tensor, Invariants and Failure Prediction, Material Characterisation	
21 Mar	*4*		Composites	Fibre Reinforced Materials, Properties, Characterisation, Laminates, Classical Laminate Theory, Failure Prediction	
28 Mar	*5*	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*
11 Apr	*6*		Thin-walled Beams (Shear and Torsion)	Shear Flow, Torque Diagrams, Torsion of Open and Closed Sections, Shear of Open and Closed Sections, Shear Centre	
18 Apr	*7*		Structural Idealisation	Bending, Shear, Torsion	
25 Apr	*8*		Public Holiday		
02 May	*9*		Complex Thin-walled Structures	Combined Open-Closed, Multiple Box, Built-up-Beams	
09 May	*10*	3	Buckling	Columns, Shells	*Megson A4, B6 Flabel*
16 May	*11*		Stiffened Panel Buckling	Modes of Buckling, Crippling, Limit and Ultimate Buckling, Shear Buckling, Curved Panel Buckling	
23 May	*12*		Aeroelasticity	Divergence, Control Reversal, Flutter	

6. Assessment

Assessment overview

Assessment	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
Module Quizzes (2)	2 x 1hour	20%	1,2	Correct answer, Correct working, Logical approach	1: Midnight Friday Wk 4 2: Midnight Friday Wk 9	N/A	After quizzes close for all students.
Lab Reports (2)	TBD	20%	1,2	Report writing and communication skills.	1: Midnight Friday Wk 6 2: Midnight Friday Wk 10	2 days after respective due date	2 weeks after submission
Group Structural Analysis Project	TBD by the class	20%	1,2,3	TBD by the class	Midnight Friday Wk 12	4 days after due date	2 weeks after submission
Final exam	2 hours	40%	1,2,3	Correct answer, Correct working, Logical approach	Exam period, date TBC	N/A	Upon release of final results

Major Assignment

This class will feature a major group project which will run for the duration of semester and will utilise the unique space provided for the demonstration class. The project will be due at the end of Week 12.

You will be tasked with (as a group) analysing the structure of an existing airframe using the concepts and analysis methods introduced throughout the semester. The group will be required to develop an overall analysis and each individual will submit a summary of their individual contributions to the project. The form of submission is flexible. Novel and creative submission (i.e. portfolios, websites, etc) are encouraged in addition to traditional reports.

As a class, we will develop the assessment criteria for the submissions. As a group, you will have the responsibility to assess your peers' contributions to the group effort.

Assignment Guidelines

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

Late submissions will be penalised 5 marks per calendar day (including weekends). An extension may only be granted in exceptional circumstances. Where an assessment task is worth less than 20% of the total course mark and you have a compelling reason for being unable to submit your work on time, you must seek approval for an extension from the course convenor ***before the due date***. Special consideration for assessment tasks of 20% or greater must be processed through student.unsw.edu.au/special-consideration.

It is always worth submitting late assessment tasks when possible. Completion of the work, even late, may be taken into account in cases of special consideration.

Where there is no special consideration granted, the 'deadline for absolute fail' in the table above indicates the time after which a submitted assignment will not be marked, and will achieve a score of zero for the purpose of determining overall grade in the course.

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. Final examinations for each course are held during the University examination periods, which are June for Semester 1 and November for Semester 2.

Provisional Examination timetables are generally published on myUNSW in May for Semester 1 and September for Semester 2
For further information on exams, please see the Exams section on the intranet.

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 shown 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 School Office or the Engineering Student Centre prior to the examination. Calculators not bearing an "Approved" sticker will not be allowed into the examination room.

Special consideration and supplementary assessment

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

7. Attendance

You are required to attend a minimum of 80% of all classes, including lectures, labs and seminars. It is possible to fail the course if your total absences equal to more than 20% of the required attendance. Please see the School intranet and the UNSW attendance page for more information.

8. Expected resources for students

Microsoft Teams

Microsoft's new communication platform, Microsoft Teams, will be piloted 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

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.

Other Resources

If you wish to explore any of the lecture topics in more depth, then other resources are available and assistance may be obtained from the UNSW Library. One starting point for assistance is the library website: https://www.library.unsw.edu.au/

9. 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:

- A change in course hours from 3h lecture + 1h demonstration to 2h lecture + 2h demonstration to provide more time for worked examples and create new opportunities for class discussion

- The addition of a new laboratory exercise in place of a research project.
- Slight reduction in the course workload through the transfer of some content to AERO3110.

10. 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: 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

Further information on School policy and procedures in the event of plagiarism is available on the intranet.

11. Administrative matters and links

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

- Attendance, Participation and Class Etiquette
- UNSW Email Address
- Computing Facilities
- Assessment Matters (including guidelines for assignments, exams and special consideration)
- Academic Honesty and Plagiarism
- Student Equity and Disabilities Unit
- Health and Safety
- Student Support 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