



UNSW
AUSTRALIA

Course Outline

Semester 1, 2015

Never Stand Still

Faculty of Engineering

School of Mechanical and Manufacturing Engineering

AERO3410

Aerospace Structures

Contents

1. COURSE STAFF	3
2. COURSE DETAILS	3
3. TEACHING STRATEGIES	6
4. RATIONALE FOR INCLUSION OF CONTENT AND TEACHING APPROACH	6
5. ASSESSMENT	7
6. ACADEMIC HONESTY AND PLAGIARISM	12
7. COURSE SCHEDULE	13
8. RESOURCES FOR STUDENTS	14
9. COURSE EVALUATION AND DEVELOPMENT	14
10. ADMINISTRATIVE MATTERS	15

Course Outline

AERO3410 Aerospace Structures

1. COURSE STAFF

Convenor and Lecturer

Dr Garth Pearce
Electrical Engineering (G17) Room 464B
Tel: 9385 4127
Email: g.pearce@unsw.edu.au

Demonstrators

TBA through Moodle.

Consultation

Consultation concerning this course is available during the demonstration class. Outside of these hours the convenor and demonstrators can be contacted through the Moodle platform; either via a forum or through direct messaging. *Any questions about course content and assessment that are not of a private nature should be directed to the appropriate Moodle forum.* Any personal queries about course administration can be directed to Garth via direct email.

2. COURSE DETAILS

Aims of the course

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.

Units of credit

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.”

For a standard 24 UoC in the semester, this means 600 hours, spread over an effective 15 weeks of the semester (thirteen weeks plus stuvac plus one effective exam week), or 40 hours per week, for an average student aiming for a credit grade. Various factors, such as your own ability, your target grade, etc., will influence the time needed in your case. Some students spend much more than 40 h/w, but you should aim for not less than 40 h/w on coursework for 24 UoC.

This means that you should aim to spend not less than about 10 h/w on this course, i.e. an additional 6 h/w of your own time. This should be spent in making sure that you

understand the lecture material, completing the set assignments, further reading about the course material, and revising and learning for the examination.

Summary 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 one hour of demonstrations a week to cover example problems from all modules. Two laboratories will be available on a flexible timeframe to assist with your understanding of unsymmetrical beams loaded in bending and shear. A mini research project into an aerospace structures related discipline will run over the entire semester.

Relationship to entire program

All aerospace vehicles require an airframe. Aerospace Structures is a cornerstone course that will underpin your understanding of aerospace structural design and analysis. The material in this course will be directly applied in Aerospace Design 1 and 2 in future semesters.

It is recommended that students with an interest in structural design also student the finite element method in MECH9610. Finite element analysis is the industry standard for structural analysis of complex problems and complements the analytical techniques introduced in AERO3410.

Student learning outcomes

By the end of this course it is expected that you will be able to:

1. describe the layout of aircraft structures and the role played by different components;
2. decide upon materials to be used for specific aerospace applications based on design drivers, material properties and ageing constraints;
3. use methods for determining stress and deflections of thin walled single and multi-celled stiffened structures for axial loads, bending and shear and apply these techniques to the analysis of wing and fuselage structures in aircraft;
4. analyse the buckling of thin walled structures under compression, bending and shear and be able to determine the collapse load of structures under compression loads;
5. describe and predict the onset of aeroelastic phenomena in fixed wing aircraft;
6. generate and critique a research proposal.

Graduate attributes

Please refer to UNSW graduate attributes:

<https://my.unsw.edu.au/student/atoz/GraduateAttributes.html>

UNSW aspires to develop graduates who are rigorous scholars, capable of leadership and professional practice in a global community. The university has, thus, articulated the following Graduate Attributes as desired learning outcomes for ALL UNSW students.

UNSW graduates will be:

1. Scholars who are:

- a) understanding of their discipline in its interdisciplinary context (*)
- b) capable of independent and collaborative enquiry (*)
- c) rigorous in their analysis, critique, and reflection (*)
- d) able to apply their knowledge and skills to solving problems (*)
- e) ethical practitioners
- f) capable of effective communication (*)
- g) information literate (*)
- h) digitally literate (*)

2. Leaders who are:

- a) enterprising, innovative and creative
- b) capable of initiating as well as embracing change(*)
- c) collaborative team workers

3. Professionals who are:

- a) capable of independent, self-directed practice (*)
- b) capable of lifelong learning (*)
- c) capable of operating within an agreed Code of Practice (*)

4. Global Citizens who are:

- a) capable of applying their discipline in local, national and international contexts
- b) culturally aware and capable of respecting diversity and acting in socially just/responsible ways
- c) capable of environmental responsibility

Graduate attributes targeted and developed in this course are marked with an asterisk (*).

3. TEACHING STRATEGIES

Your learning in the course will be supported by best practice teaching methodologies. The approach to teaching in the course is based on modified [Bloom's Taxonomy](#) and the formation of assessments is based on [SOLO Taxonomy](#). New teaching strategies and teaching technologies are deployed every year to ensure that the course is as up-to-date as possible to leading teaching standards.

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.
- *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 attempt to apply the lessons learnt in class. Discussing the obstacles you faced in the questions with a tutor allows to grasp the key tools that you will need to address future problems.
- *Adaptive Demonstrations*: A selection of adaptive demonstrations will be provided which cover key topics in the course. Each demonstration 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.
- *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.

4. RATIONALE FOR INCLUSION OF CONTENT AND TEACHING APPROACH

The material in Aerospace Structures is intended to provide the fundamental tools available to aerospace engineers to analyse and design aircraft structures. As with all university courses, it is far from exhaustive, but will give you the platform to expand your skills. The modules in the course build on one another and progressively grow in complexity. By the end of this course you will be ready to tackle simple structural design problems.

The teaching strategy, as outlined above, focuses on a blended approach with multiple facets to improve your understanding of the core concepts in the course. The blended teaching approach also caters for the range of learning techniques which are unique to each individual student.

Analytical concepts such as the analysis of aircraft structures are best learnt by practice on worked examples. The course texts have numerous worked examples and students are encouraged to participate in class demonstrations and self-assessment. Time will be set aside during class for discussion of the practical application of the techniques being taught. You will have feedback and discussion while the topic is fresh in your mind to improve the learning experience.

A number of online adaptive demonstrations have been developed for the content in the course. These demonstrations break the questions down into smaller problems and deliver guided feedback to you as you progress. The demonstrations augment traditional demonstration learning and use best practice learning and teaching techniques to aid the learning experience.

Research is a key part of your studies next year and also plays a large role in many engineering careers. UNSW is also a key research intensive university in Australia and has many opportunities for world leading research. To prepare you for this, this course, along with others in 3rd year aerospace engineering, will involve a mini research project. This research project will introduce you to the fundamentals of research and writing research proposals.

The course text by Megson is internationally recognised and will be closely followed. It is available on-line through the library but you are strongly encouraged to purchase a copy as it will be a valuable reference during your career as an aerospace engineer. Additional non-assessable content will be added to lessons to enrich the analytical content and provide a link to current relevant topics in the aerospace industry.

5. ASSESSMENT

Submission

In this course there are currently no plans to use the school assignment boxes for physical assignments; all assignments will be submitted digitally. If there are technological difficulties which force the use of physical assignment copies, they must include a School cover sheet which is available from the school website and are to be submitted before 11am on the due date so that they can be processed before close of business.

Online submissions are required to be submitted via Moodle. No cover sheet is required as all assignments will be identified through your Moodle account. *All digital assignments are due by 5pm on the due date.* An additional allowance will be granted automatically to submit assignments until 11:55pm without penalty, but you accept any risk of technical difficulties with submission. *If you try to submit between 5pm and 11:55pm and Moodle does not accept the submission for any reason the assignment will be considered late.*

All submissions are expected to be neat and clearly set out. Pertinent calculations should be shown (not exhaustive pages of numerical substitution) as, in the event of incorrect answers, marks may be awarded for method and understanding. Calculations should be shown professionally in any report; *scans of hand calculations will not be accepted.* The submission of online material should follow the instructions given on the appropriate Moodle page.

Late Submission

Late submissions will attract a penalty of 10% of the *awarded* mark per calendar day or part thereof. For small assessment tasks (5 marks or lower), the penalty incurred will be 1 mark per calendar day. 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 <https://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.

NOTE: Any submission with a peer review component (such as elements of the Mini Research Project) *cannot be accepted or graded* if submitted late due to technical limitations of the peer assessment process.

Criteria

In addition to any criteria specified in the assignment hand-outs, the following criteria will be used to grade assignments:

1. For reports:

- Identification of key facts and the integration of those facts in a logical development.
- Clarity of communication: this includes development of a clear and orderly structure and the highlighting of core arguments.
- Sentences in clear and plain English: this includes correct grammar, spelling and punctuation.
- Correct referencing of source materials

2. For numerical calculations:

- Accuracy of numerical answers.
- *Important* working shown. Note that this does not mean that you need to produce reams of numerical substitution. Only show working which is not immediately obvious from the context of your calculations.
- Use of diagrams, where appropriate, to support or illustrate the calculations.
- Use of graphs, where appropriate, to support or illustrate the calculations.
- Use of tables, where appropriate, to support or shorten the calculations.
- Neatness.

Marks

The final course mark will be determined by the following weightings:

Task	%	Learning Outcomes Assessed	Graduate Attributes Assessed	Tasks or Submissions Due in Week(s)
Demonstrations	10	1-5	1(c-d)	Ongoing
Mid Semester Exam	15	1-3	1(c-d,f)	8
Major Assignment	20	1-5	1(a-d,f-h),3(a-c)	12
Mini Research Project	20	6	1(a-d,f-h),2(b),3(a-c)	4,9,11,13
Final Exam	35	1-5	1(c-d,f)	
Total	100			

In order to pass the course, you must achieve an overall mark of at least 50%.

Demonstrations

You need to acquire a *demonstration book*. Any exercise book will do. The book will serve as a record of all the demonstrations you have attempted, including the adaptive demonstrations (more info on these in a moment). Each time you attempt a demonstration you should complete it in your demonstration book and any working to support the adaptive demonstrations should also be completed in the same book.

At regular intervals throughout the semester (at least 3 times) you should have your laboratory book signed and dated by a tutor after your most recent entry. At the last demonstration you will submit your book for assessment. It will be returned to you as soon as possible for study.

Adaptive demonstrations are online resources available through the Moodle page. They are similar to traditional demonstrations but will provide immediate feedback on your progress as you go along. These demonstrations have been very popular with students and new ones are constantly being developed to support the course.

Your demonstration mark will be assigned based on the quality of your demonstration book (progress throughout the semester, completion rate, score on adaptive demonstrations, etc.). No demonstrations are compulsory, but you should complete as many as you can to show your progress through the course.

The demonstrations will assess learning outcomes 1-5.

Mid-Semester Examination

There is a 1h 30 min mid-session exam in week 8. The exam will overlap with class hours but will not fall completely within them. Please consult Moodle to ensure you are aware of the location and timing of this exam. If you have any clashes with other classes, please let Garth know immediately.

The mid-semester examination will provide both summative and formative assessment of your individual progress in the course and will assess learning outcomes 1-3.

Major Assignment

A major assignment will be handed out week 6 and will be due in week 12. The assignment will cover the design and analysis of a major structural component such as a wing or fuselage section. The assignment will assess learning outcomes 1-5.

Mini Research Project

Guidelines for submission of the mini research project are available on Moodle. The submission will be completed in four parts.

The mini research project will assess learning outcome 6. Research is a feature of all professional engineering practice, although it comes in many forms. The research skills you learn during this task are specifically targeted at scholarly academic research but will be applicable for the future pursuit of all knowledge. This task includes peer assessment and personal reflection; skills which are critical in order to achieve the UNSW professional graduate attributes.

Proposal Abstract (2 Marks)

Create a research proposal of 100 words or less. Examples of research proposals are given on Moodle. Submit your proposal draft along with the topic name by the end of week 4.

Select your research topic from within the broad fields of:

- Composite materials
- Advanced aerospace alloys
- Aircraft aging: fatigue, corrosion, wear, NDI
- Advanced aircraft mechanics: vibration, buckling, aeroelasticity
- Novel manufacturing and joining techniques for aircraft structures

The key to a successful project will be a topic that has excellent research potential but also is interesting to you personally.

Draft Proposal (5 Marks – Peer Assessed)

Construct your research proposal in detail. The proposal must include a concise problem statement, proposed methodology, expected results and an assessment of how the project will contribute to knowledge. You must describe the findings from at least five journal articles and explain how these findings relate to the individual aspects of your research topic. The detailed proposal will be due in Week 9.

Peer Review (3 Marks)

You will be assigned approximately three proposals at random and you will be required to comment on each project by filling in the assessment sheet and submitting it through Moodle. The quality of this feedback will be assessed. The assessment will be due in Week 11.

Final Proposal and Rejoinder (10 Marks)

You will be given three sets of feedback on your detailed proposal through Moodle. You will be given a short time to accept the feedback and modify your work accordingly or reject the comments by giving a valid reason for the rejection.

Both your updated final proposal and rejoinder will be submitted electronically via Moodle and will be due in Week 13.

Final Examination

There will be one three-hour examination at the end of the semester, covering all material in the course.

You will need to provide your own calculator, from the list approved by UNSW: <https://student.unsw.edu.au/exam-approved-calculators-and-computers> for the examination. 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 *Administrative Matters for All Courses*, available from the School website.

In this course, supplementary assessment will only be provided for the final examination and is still at the discretion of the course authority. Special consideration for other assessment tasks, if granted, will allow the assessment task to be removed from the final grade and the other grades will be adjusted accordingly.

6. ACADEMIC HONESTY AND PLAGIARISM

Plagiarism is using the words or ideas of others and presenting them 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 which provides essential information for avoiding plagiarism: <https://student.unsw.edu.au/plagiarism>.

There is a range of resources to support students to avoid 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. Information is available on the dedicated website Plagiarism and Academic Integrity website (link above).

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 a honours thesis) even suspension from the university. The Student Misconduct Procedures are available here: <https://student.unsw.edu.au/conduct>.

Further information on School policy and procedures in the event of plagiarism is presented in a School handout, *Administrative Matters for All Courses*, available on the School website.

7. COURSE SCHEDULE

Lectures

Week	AERO3410
1	Airframe Basics: Flight Loads; Loads on the Airframe; Role of Components; Airframe Types; Fundamentals of Stressed Skin Design Resource - Megson B1-2
2	Module 1 - Aerospace Materials and their Properties: Choice of Aerospace Materials; Material Characterisation; Ageing of Airframes; Elasticity Theory; Failure Prediction; Composites Resource - Megson A1, B1
3	
4	
5	Module 2 - Analysis of Thin-walled Structures: Thin-walled Approximation; Structural Idealisation; Bending, Shear and Torsion of Complex Beams; Detailed Stressing of Joints and Cut-outs
Break	
6	Module 2 continued Resource - Megson B3-5, Flabel
7	
8	
9	
10	
11	Module 3 - Structural Instability and Aeroelasticity: Buckling of Columns and Plates; Stiffened Panel Analysis and Design; Aeroelasticity - Divergence, Control Reversal and Flutter Resource - Megson A4, B6, Flabel
12	
13	

8. RESOURCES FOR STUDENTS

Learning Management System

The Moodle LMS, <https://moodle.telt.unsw.edu.au/> will be used for this course. Lecture notes, demonstrations, assignments, links and forums will be available on Moodle. Moodle is a powerful tool that you are encouraged to use for all course needs.

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.

Recommended Internet sites

There are many websites giving lectures, papers and data. These websites will be identified in the lectures and on Moodle.

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: www.library.unsw.edu.au/.

9. COURSE EVALUATION AND DEVELOPMENT

Aerospace Structures was completely revised for 2014. In a response to the school's curriculum review project in 2013, it was decided that AERO3410 needed to present a much more comprehensive approach to aircraft structural analysis while removing some of the content that could be taught to a more general audience, such as the finite element method (FEM). As a result, AERO3410 and AERO4410 were disbanded and a new AERO3410 was designed with the best parts of the two old courses and some brand new content as well.

In 2014 the course was received very well. The only concern from most students was the amount of assessment. I have picked over the assessment structure and I'm afraid that there isn't much that can be done about each due date; there isn't room to move things around. Instead, the size and complexity of each assessment task will be reduced somewhat in 2015.

10. ADMINISTRATIVE MATTERS

You are expected to have read and be familiar with *Administrative Matters for All Courses*, available from the school website:

<http://www.engineering.unsw.edu.au/mechanical-engineering/forms-and-guidelines>.

This document contains important information on student responsibilities and support, including special consideration, assessment, health and safety, and student equity and diversity.

Equity and diversity

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 convenor prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Student Equity and Disabilities Unit (SEADU) by phone on 9385 4734, email seadu@unsw.edu.au or via the website www.studentequity.unsw.edu.au. The office is located on the Ground Floor of the Goodsell building (F20).

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.

G Pearce
February 2015