UNSW AUSTRALIA

Course outline

Semester 1 2017

Never Stand Still | Engineering | Mechanical and Manufacturing Engineering

AERO3410

Aerospace Structures

Contents

1. Staff contact details

Contact details and consultation times for course convenor

Name: Garth Pearce
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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 (anonymously if desired)
2. Use the appropriate forum on the Moodle page
3. Send a direct message via Moodle to a demonstrator for an answer or to arrange a meeting
4. Arrange a consultation with the course convenor via email or Moodle direct message.

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

Name: Nayeem Chowdhury
Role: Head Demonstrator
Office Location: Ainsworth Building 208
Email: nayeem.chowdhury@unsw.edu.au

Others TBA through Moodle.

2. 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

Course timetable: http://timetable.unsw.edu.au/2017/AERO3410.html

	Day	Time	Location
Lectures	Wednesday	1pm - 3pm	Chemical Sc M10
Demonstrations	Monday	4pm – 6pm	Mathews 103

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 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.

Aims of the course
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; and
- the ability to design aerospace structures against failure, degradation, instability and aeroelasticity.

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

1. decide upon materials to be used for specific aerospace applications based on component function, design drivers, material properties and ageing constraints;
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;
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; and

4. generate and critique a research proposal based on state-of-the-art aerospace structures research.

This course is designed to address the below learning outcomes 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.	generate and critique a research proposal based on state-of-the-art aerospace structures research	1.4

3. 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.

4. Course schedule

Date	Week	Mod	Topic	Concepts	Suggested Readings
1-Mar	1	N/A	Airframe Basics	Flight Loads, Loads on the Airframe, Load Paths, Role of Components, Airframe types, Stressed Skin Design	Megson B1-2
8-Mar	2	1	Aerospace Materials	Drivers for Airframe Materials, Beneficial Properties, Choice of Materials, Fatigue, Corrosion, Wear, Creep	Megson A1,B1
15-Mar	3		Solid Mechanics	Elasticity, Stress and Strain Tensor, Invariants and Failure Prediction, Material Characterisation	
22-Mar	4		Composites	Fibre Reinforced Materials, Properties, Characterisation, Laminates, Classical Laminate Theory, Failure Prediction	
29-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 B3-5 Flabel
5-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	
12-Apr	7		Structural Idealisation	Bending, Shear, Torsion	
26-Apr	8		Complex Thin-walled Structures	Combined Open-Closed, Multiple Box, Built-up-Beams	
3-May	9		Joints and Clips	Single and Double Overlap, Load Transfer, Stress Concentration, Shear Clips, Tension Clips, Joint Groups, Bonded Joints	
10-May	10	3	Buckling	Columns, Shells	Megson A4, B6 Flabel
17-May	11		Stiffened Panel Buckling	Modes of Buckling, Crippling, Limit and Ultimate Buckling, Shear Buckling, Curved Panel Buckling	
24-May	12		Aeroelasticity	Divergence, Control Reversal, Flutter	

5. 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.
Group Structural Analysis Project	TBD by the class	20%	1-3	TBD by the class	Midnight Friday Wk 12	4 days after due date	2 weeks after submission
Mini Research Project	8 pages max	20%	4	Report writing and communication skills, inventive solutions to research challenges	Deadlines in Wk 4,9,11,13 (see below)	*See below	Wk 11 (Draft) During exam period (Final)
Final exam	2 hours	40%	1-3	Correct answer, Correct working, Logical approach	Exam period, date TBC	N/A	Upon release of final results

* The draft Research Project report and the Peer Review exercise cannot be submitted late because your submission is tied to the progress of others. The final Research Project report can be submitted late and attract the usual penalties (Absolute fail will be 2 days after submission).

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, you 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.

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

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 Engineers Australia Graduate Attributes.

Proposal Abstract (No Marks, must be approved to progress)
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 Friday Week 9.

Peer Review (5 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 and you will be provided a mark. The assessment will be due early Week 11.

Final Proposal and Rejoinder (10 Marks)
You will be provided your peers' feedback on the draft proposal. 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 submitted electronically via Moodle and will be due in Week 13.

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.

6. Expected 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: https://www.library.unsw.edu.au/

7. Course evaluation and development

Feedback on the course is gathered periodically using various means, including the UNSW myExperience (formerly CATEI) 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
- Improvements to the optional course laboratory organisation
- Alignment of the research project with other course content

8. 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.

9. Administrative matters

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

Garth Pearce
February 2017

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