UNSW AUSTRALIA

Course Outline

Semester 1 2016

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: Dr Garth Pearce
Office location: Ainsworth Building Rm 208
Tel: (02) 9385 4127
Email: g.pearce@unsw.edu.au

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

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/2016/AERO3410.html

	Day	Time	Location
Lectures	Thursday	9am-12pm	Ainsworth G02
Demonstrations	Thursday	1–2pm	Red Centre Central M032
Midsession	Thursday	12-2pm	Old Main G31 (Wk 8 Only)

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.

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;
- 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;

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 approaches. The objective, when at all possible, is for you to experience the concepts in multiple modes (theory, example problems, simulations, demonstrations, 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 many 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 attempt to 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 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. Course schedule

Date	Week	Mod	Topic	Lecture Content	Suggested Readings
3/03/16	1	N/A	Airframe Basics	Flight Loads, Loads on the Airframe, Load Paths, Role of Components, Airframe types, Stressed Skin Design	Megson B1-2
10/03/16	2	1	Aerospace Materials	Drivers for Airframe Materials, Beneficial Properties, Choice of Materials, Fatigue, Corrosion, Wear, Creep	Megson A1,B1
17/03/16	3		Solid Mechanics	Elasticity, Stress and Strain Tensor, Invariants and Failure Prediction, Material Characterisation	
24/03/16	4		Composites	Fibre Reinforced Materials, Properties, Characterisation, Laminates, Classical Laminate Theory, Failure Prediction	
31/03/16	Break				
7/04/16	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
14/04/16	6		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	
21/04/16	7		Structural Idealisation	Bending, Shear, Torsion	
28/04/16	8		Complex Thin-walled Structures	Combined Open-Closed, Multiple Box, Built-up-Beams	
5/05/16	9		Joints and Clips	Single and Double Overlap, Load Transfer, Stress Concentration, Shear Clips, Tension Clips, Joint Groups, Bonded Joints	

12/05/16	10	3	Buckling	Columns, Shells	Megson A4, B6 Flabel
19/05/16	11		Stiffened Panel Buckling	Modes of Buckling, Crippling, Limit and Ultimate Buckling, Shear Buckling, Curved Panel Buckling	
26/05/16	12		Aeroelasticity	Divergence, Control Reversal, Flutter	

5. Assessment

Assessment Overview

Assessment	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Marks returned
Demonstration Problems	10	1-3	Correct results, working and attempted solutions	Thursday Week 13 (during demonstration)	1 week after collection
Mid Semester Exam	15	1-2	Correct answer, Correct working, Logical approach	Thursday Week 8 (12-2pm)	2 weeks after exam
Major Assignment	20	1-3	Technical Results, Report writing and communication skills, creative problem solving	Week 12	3 weeks after submission
Mini Research Project	20	4	Report writing and communication skills, inventive solutions to research challenges	Week 4,9,11,13	3 weeks after submission
Final Exam	35	1-3	Correct answer, Correct working, Logical approach	Exam period	

Assignments

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 1-3.

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 4. Research is a feature of all professional engineering practice, although it comes in many forms. The research skills you learn during this task a 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 (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 submitted electronically via Moodle and will be due in Week 13.

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

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.

Submission

In this course all assignments will be submitted digitally. Online submissions are required to be submitted via Moodle. No cover sheet is required as all assignments will be identified through your Moodle account. In addition, you must agree to the UNSW plagiarism rules in order to have access to the online submission box. If there are technological difficulties which force the use of physical assignment copies, additional advice will be provide in class and on the Moodle page.

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 encounter technical difficulties for ANY reason, the assignment will be considered late.

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.

SPECIAL 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.

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 demonstration book signed and dated by a demonstrator 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 you 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 1-3.

Examinations

Mid-Semester Exam

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 1-2.

Final Exam

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

Attendance

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: http://info.library.unsw.edu.au/web/services/services.html

7. Course evaluation and development

This section is crucially important. The CATEI process is central to the improvement and development of our courses over time. Students need to see value for the time and effort that they invest in the process; otherwise they will not participate seriously. This section in

each course outline reinforces to students that their feedback is taken seriously and incorporated into course design and development.

Feedback on the course is gathered periodically using various means, including the Course and Teaching Evaluation and Improvement (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 the addition of more demonstration questions and solutions to aid you with your personal study.

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 2016

Appendix A: Engineers Australia (EA) Professional Engineer Competency Standards

	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