MMAN3400

Mechanics of Solids 2

Term One // 2021

School of Mechanical and Manufacturing Engineering // UNSW Engineering

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Garth Pearce	g.pearce@unsw.edu.au	Thursday 10-11 am (before lecture)	Teams, Ainsworth Building 208E	Teams

Lecturers

Name	Email	Availability	Location	Phone
Chun Wang	chun.h.wang@unsw.edu.au		Teams	Teams

School Contact Information

Location

UNSW Mechanical and Manufacturing Engineering

Ainsworth building J17, Level 1

Above Coffee on Campus

Hours

9:00–5:00pm, Monday–Friday*

*Closed on public holidays, School scheduled events and University Shutdown

Web

School of Mechanical and Manufacturing Engineering

Engineering Student Support Services

Engineering Industrial Training

UNSW Study Abroad and Exchange (for inbound students)

UNSW Future Students

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

(+61 2) 9385 4097 – School Office**

**Please note that the School Office will not know when/if your course convenor is on campus or available

Email

Engineering Student Support Services – current student enquiries

- e.g. enrolment, progression, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries

- e.g. admissions, fees, programs, credit transfer

School Office – School general office administration enquiries

- NB: the relevant teams listed above must be contacted for all student enquiries

Course Details

Credit Points 6

Summary of the Course

This course further develops foundational solid mechanics concepts first introduced in *Engineering Mechanics* and *Mechanics of Solids 1.* The generalises the concepts developed in the previous courses (such as bending and shear stresses in beams), while adding new analysis tools to predict the stability and lifetime of engineering structures. Topics usually include:

- Unsymmetrical bending of simple bending and built-up beams
- Shear stress/flow in beams subjected to shear force and torque
- Shear centre
- Column and plate buckling
- Theory of elasticity: compatibility - equilibrium - constitutive equations - plane stress/strain
- Membrane stress in axisymmetric shells
- Deflection analysis based on the principle of virtual work
- Fracture mechanics - modes of fracture, crack-tip stresses, stress intensity factor, fracture toughness
- Crack growth due to fatigue.

Course Aims

This course aims to expand your solid mechanics toolset by generalising concepts introduced in earlier mechanics courses and adding new tools to predict the performance of structures (deflection, stability, lifetime). The course will give you the skills required to tackle advanced solids mechancis electives such as *Finite Element Methods* and *Mechanics of Fatigue and Fracture.*

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. determine stresses in axisymmetric shells/vessels, unsymmetrical bending, shear and column buckling	PE2.1, PE2.2
2. analyze deflection of trusses and beams using principle of virtual work	PE2.1, PE2.2
3. investigate mechanics of fracture and fatigue	PE1.5, PE2.1
4. develop further your skill of technical problem-solving	PE2.2, PE2.1

Teaching Strategies

Effective learning is supported when you are actively engaged in the learning process and by a climate of enquiry, and these are best achieved through learning activities like lectures and problem-solving classes using practical examples combined with laboratory demonstrations and hands-on activities.

You become more engaged in the learning process if you can see the relevance of your studies to professional, disciplinary and/or personal contexts. This relevance is shown in all parts of the course through lectures by way of examples drawn from industry.

Discussions are encouraged between you, others in the class and the lecturer. The diversity of experiences is acknowledged. Your experiences are drawn on to illustrate various aspects, and this helps to increase motivation and engagement.

Assessment

Assessment Tasks

Assessment task	Weight	Due Date	Student Learning Outcomes Assessed
Quizzes	20%	See description	1, 4
Lab Reports	20%	Monday Week 9	1, 4
Block Test	20%	6-8pm Thursday Week 7 (see timetable)	1, 4
Final Exam	40%	Exam period	1, 2, 3, 4

Assessment Details

Assessment 1: Quizzes

Start date: Not Applicable

Length: 90 minutes each

Details:

Two quizzes of equal value:

- Quiz 1 (Week 3): Topics from Week 1 and 2
- Quiz 2 (Week 5): Topics from Week 3 and 4

Additional details:

Specific date/times will be provided via Teams.

Quiz will be conducted through Moodle.

Assessment 2: Lab Reports

Start date: Not Applicable

Details:

There will be two lab experiments provided during term. Information will be provided to allow the reports to be completed remotely. Optional in-person lab demonstrations will be available during flex week.

Additional details:

Submitted through Teams. Instructions and rubric will be provided.

Assessment 3: Block Test

Start date: Not Applicable

Length: 2 hours

Details:

This test will cover material delivered in Weeks 1-5 (i.e. Block 1).

Additional details:

More information will be provided via Teams.

The exam will be online via Moodle.

Assessment 4: Final Exam

Start date: Not Applicable

Details:

Scheduled final exam. It covers all the topics taught in the course, with a focus on the material taught after flex week. The exam will run for two hours.

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

Course Schedule

View class timetable

Timetable

Date	Type	Content
O Week: 8 February - 12 February		
Week 1: 15 February - 19 February	Lecture	**Theory of Elasticity** • Stress/Strain tensors • Stress and strain transformations in 2D and 3D • Stress invariants • Constitutive laws • Theories of failure
Week 2: 22 February - 26 February	Lecture	**Classical Bending of Beam Sections** • Products of inertia and area • Simple and unsymmetrical bending • Composite beams
Week 3: 1 March - 5 March	Lecture	**Shear and Torque of Beam Sections** • Torsion of solid sections (revision) • Shear flow • Shear flow in Open Sections • Shear flow in Closed Thin-walled Sections • Shear centre
	Assessment	**Quiz 1** Covers material from Weeks 1 and 2.
Week 4: 8 March - 12 March	Lecture	**Shear of Beam Sections Cont.**
Week 5: 15 March - 19 March	Lecture	**Membrane Stress in Thin Axisymmetric Shells** • Thin-walled cylindrical and spherical pressure vessels (revision)

		• General axisymmetric shells
		• Case studies:
		  ◦ Spherical shells (revisited)
		  ◦ Cylindrical shells (revisited)
		  ◦ Conical shells
		  ◦ Toroidal shells

	Assessment	**Quiz 2** Covers material from Weeks 3 and 4.
Week 6: 22 March - 26 March	Tut-Lab	**Labs** Optional in-person lab demonstration. Timeslot booking will be provided in Teams.

Week 7: 29 March - 2 April	Lecture	**Buckling of Columns and Shells**
		
		• Euler buckling of columns
		• Effect of boundary conditions
		• Non-idealised buckling of columns
		  ◦ Inelastic buckling
		  ◦ Secant formula
		  ◦ Design considerations
		• Shell buckling

	Assessment	**Block Test** Covers material from Weeks 1-5.
Week 8: 5 April - 9 April	Lecture	**Principles of Virtual Work** • Strain energy • Work • Unit load method for truss deflection • Deflection of beams
Week 9: 12 April - 16 April	Lecture	**Statically Indeterminate Structures** • Determining redundant reaction forces • Elastic foundations
Week 10: 19 April - 23 April	Lecture	**Introduction to Fracture and Fatigue** • Fracture modes • Crack tip stresses • Stress intensity factor

		• Fracture toughness • Crack growth due to fatigue

Resources

Prescribed Resources

R. C. Hibbeler, “Mechanics of Materials”, 10th Ed. In SI Units, 2019, Pearson.

Recommended Resources

Engineering Core Courses - Solid Mechanics II

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 more interactive learning with practical examples.

Submission of Assessment Tasks

Assessment submission and marking criteria

Should the course have any non-electronic assessment submission, these should have a standard School cover sheet.

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.

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.

Late policy

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of 20 percent (20%) of the maximum mark possible for that assessment item, per calendar day.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day.

Work submitted after the ‘deadline for absolute fail’ is not accepted and a mark of zero will be awarded for that assessment item.

For some assessment items, a late penalty may not be appropriate. These are clearly indicated in the course outline, and such assessments receive a mark of zero if not completed by the specified date. Examples include:

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

Examinations

You must be available for all quizzes, tests and examinations. For courses that have final examinations, these are held during the University examination periods: February for Summer Term, May for T1, August for T2, and November/December for T3.

Please visit myUNSW for Provisional Examination timetable publish dates. For further information on exams, please see the Exams webpage.

Special Consideration

If you have experienced an illness or misadventure beyond your control that will interfere with your

assessment performance, you are eligible to apply for Special Consideration prior to submitting an assessment or sitting an exam.

UNSW now has a Fit to Sit / Submit rule, which means that if you attempt an exam or submit a piece of assessment, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

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

Please note that students will **not** be required to provide **any** documentary evidence to support absences from any classes missed **because of COVID-19 public health measures such as isolation**. UNSW will **not** be insisting on medical certificates from anyone deemed to be a positive case, or when they have recovered. Such certificates are difficult to obtain and put an unnecessary strain on students and medical staff.

Applications for special consideration **will** be required for assessment and participation absences – but no documentary evidence **for COVID 19 illness or isolation** will be required.

Academic Honesty and Plagiarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism, visit: student.unsw.edu.au/plagiarism. The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

If plagiarism is found in your work when you are in first year, your lecturer will offer you assistance to improve your academic skills. They may ask you to look at some online resources, attend the Learning Centre, or sometimes resubmit your work with the problem fixed. However more serious instances in first year, such as stealing another student's work or paying someone to do your work, may be investigated under the Student Misconduct Procedures.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis) even suspension from the university. The Student Misconduct Procedures are available here:

www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Academic Information

Credit points

Course credit is calculated in Units-Of-Credit (UOC). The normal workload expectation for one UOC is approximately 25 hours per term. This includes class contact hours, private study, other learning activities, preparation and time spent on all assessable work.

Most coursework courses at UNSW are 6 UOC and involve an estimated 150 hours to complete, for both regular and intensive terms. Each course includes a prescribed number of hours per week (h/w) of scheduled face-to-face and/or online contact. Any additional time beyond the prescribed contact hours should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

On-campus class attendance

Public distancing conditions must be followed for all face-to-face classes. To ensure this, only students enrolled in those classes will be allowed in the room. Class rosters will be attached to corresponding rooms and circulated among lab demonstrators. No over-enrolment is allowed in face-to-face class. Students enrolled in online classes can swap their enrolment from online to a **limited** number of on-campus classes by Sunday, Week 1. Please refer to your course's Microsoft Teams and Moodle sites for more information about class attendance for in-person and online class sections/activities.

Your health and the health of those in your class is critically important. You must stay at home if you are sick or have been advised to self-isolate by NSW health or government authorities. Current alerts and a list of hotspots can be found here. **You will not be penalised for missing a face-to-face activity due to illness or a requirement to self-isolate.** We will work with you to ensure continuity of learning during your isolation and have plans in place for you to catch up on any content or learning activities you may miss. Where this might not be possible, an application for fee remission may be discussed. Further information is available on any course Moodle or Teams site.

In certain classroom and laboratory situations where physical distancing cannot be maintained or there is a high risk that it cannot be maintained, face masks will be considered **mandatory PPE** for students and staff.

For more information, please refer to the
FAQs: https://www.covid-19.unsw.edu.au/safe-return-campus-faqs

Guidelines

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

- Attendance
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism

Important Links

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

Image Credit

Synergies in Sound 2016

CRICOS

CRICOS Provider Code: 00098G

Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	✓
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering 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	
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	
PE3.2 Effective oral and written communication in 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	