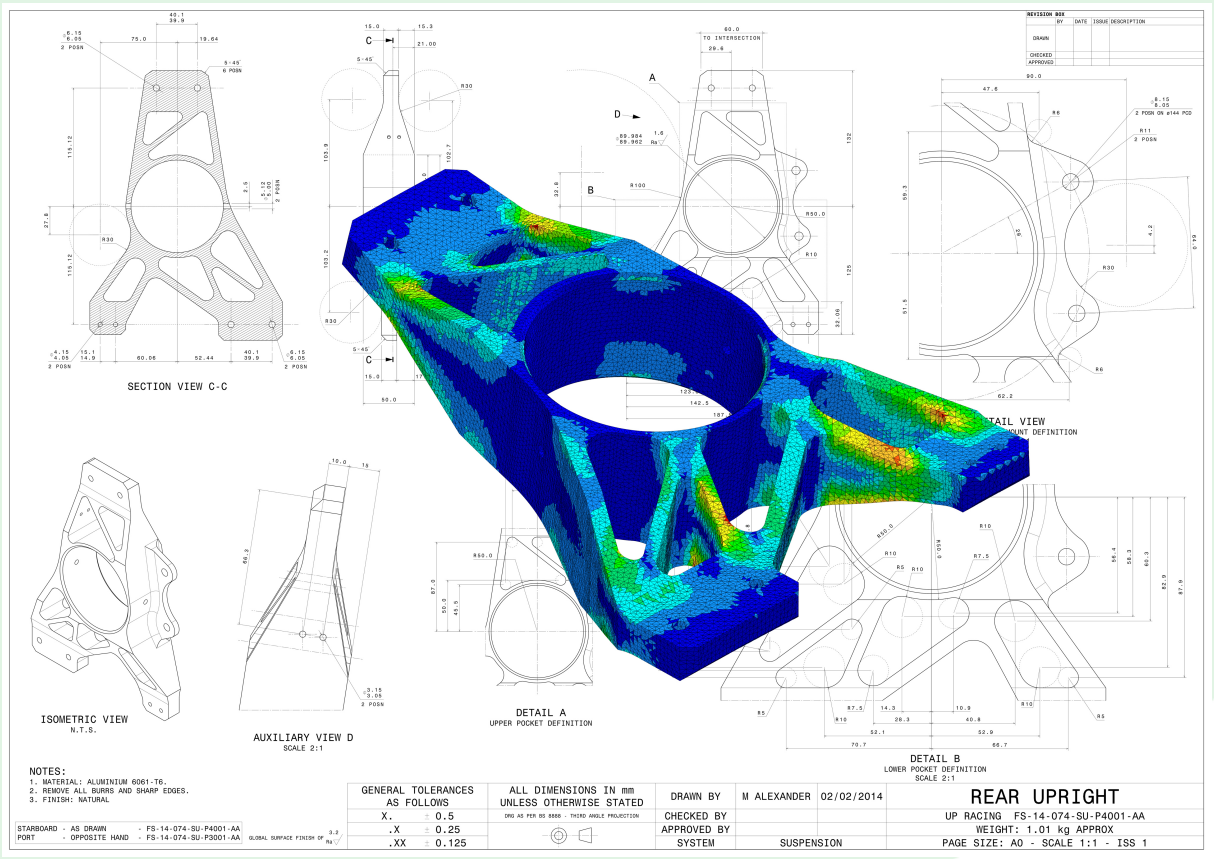
MMAN4410

Finite Element Methods

Term 1, 2022



Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Gyani Shankar Sharma	gyanishankar.sharma@unsw.edu.au	Wednesday during term	Ainsworth J17, 311E	via 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. The School will only be able to refer students on to the relevant team if contacted

Important Links

- Student Wellbeing
- Urgent Mental Health & Support
- Equitable Learning Services
- Faculty Transitional Arrangements for COVID-19
- Moodle
- Lab Access
- Computing Facilities
- Student Resources
- Course Outlines
- Makerspace
- UNSW Timetable
- UNSW Handbook

Course Details

Units of Credit 6

Summary of the Course

This course will train you to analyse real-world structural mechanics problems using the finite element method. You will be introduced to the mathematical basis of finite element analysis, on which nearly all structural analysis software is built. You will learn how to apply commercially available finite element software to solve real-world engineering problems. The course will cater to the specific challenges of engineers across all mechanical disciplines (Aerospace, Manufacturing, Mechanical, Mechatronic and Naval). Any student wishing to extend their structural analysis skills should take this course.

Course Aims

The primary aim of this course is to train you to solve complex engineering structural mechanics problems with finite element analysis. The course will provide deep insight into the operation of finite element analysis software by teaching you the underlying computational methods involved. You will be taught to execute a detailed finite element study including planning, modelling, meshing, solving, evaluating results and validating against real world data.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Apply fundamental finite element analysis techniques to solve simple engineering problems	PE2.1, PE2.2
2. Explain the underlying mathematics behind finite element analysis software solvers	PE1.2, PE3.2
3. Plan and execute appropriate finite element analyses to solve a range of solid mechanics and other engineering problems.	PE2.1, PE2.2, PE2.4, PE3.2
4. Perform a detailed finite element study to investigate a real world engineering problem	PE2.1, PE2.2, PE2.4, PE3.2, PE3.3

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.). 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. This course includes two teaching methods:

1. Lectures to introduce fundamental finite element analysis concepts
2. Computer laboratory tutorials to apply fundamental concepts in common finite element analysis packages

In addition to the lectures and tutorials, a range of blended techniques will be used through Moodle to engage the students with independent learning. The major assignment, for example, includes a significant research component that will allow each individual student to study an engineering problem specific to their own interests.

Additional Course Information

This course involves 4 hours per week (h/w) of face-to-face contact.

The normal workload expectations of a student are approximately 25 hours per term for each UOC, including class contact hours, other learning activities, preparation and time spent on all assessable work.

You should aim to spend about 11 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.

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Online Quizzes	15%	See description	1, 2
2. Group Assignment	15%	See description	1, 3, 4
3. Major Project	50%	See description	3, 4
4. Final Exam	20%	Exam period	1, 4

Assessment 1: Online Quizzes

Assessment length: 1.5 hours
Submission notes: Moodle Quiz
Due date: See description
Deadline for absolute fail: Not Applicable
Marks returned: One week after respective due dates

Class lecture material will be assessed through three online quizzes. Each quiz weighs 5%. The dates for these quizzes are as follows:

- Quiz 1 - 25th February (Friday Week 02)
- Quiz 2 - 18th March (Friday Week 05)
- Quiz 3 - 1st April (Friday Week 07)

Assessment 2: Group Assignment

Assessment length: 20 Pages max
Due date: See description
Deadline for absolute fail: 18th March (Friday Week 05)
Marks returned: Two weeks after submission

You will work in a group to design and analyse a practical engineering system. A report based on this activity is due on 11th March (Friday Week 04). In the flexibility week, you will have the opportunity (optional) to 3D print and test your design. Feedback given on this report is intended to assist you in understanding the expectations of the Major Project draft and final reports. Detailed submission guidelines and marking rubrics will be provided on Moodle.

As in the professional practice of engineering, you will not choose the team that you work with; however, you may assign the different elements of the task among team members as you see fit. A group ‘peer assessment’ tool will be used to measure team member contribution and marks adjusted accordingly.

Assessment 3: Major Project

Assessment length: Final Report: 30 pages
Due date: See description
Deadline for absolute fail: 5 days after respective submission dates
Marks returned: Two weeks after respective submission dates

You will complete a flexible major project which will form the largest component of the assessment for the course. The assessment will be broken into pieces to ensure that adequate progress is being made throughout the term:

- Mentor/topic selection – 0%
    - Each mentor will supervise one (or a few) projects related to their expertise
    - Due date: 28th March (Monday Week 03)
- Project proposal – 0%
    - A detailed summary of what you plan to do to address the topic problem
    - Due date: 4th March (Friday Week 03)
- Portfolio – 10%
    - A portfolio of work completed towards your project.
    - In addition to the project work, it can (and should) include class examples that have helped you to define your project
    - Due date: 8th April (Friday Week 08)
- Peer Evaluation and Reflection – 10%
    - Review the work of others conducting different analyses. Provide constructive feedback and review your own work critically.
    - Due date: 14th April (Thursday Week 09)
- Final Report – 30%
    - The final report of your work
    - Due date: 23rd April (Friday Week 10)
    - Detailed submission guidelines and marking rubrics will be provided on Moodle.

Assessment 4: Final Exam

Assessment length: 2 hours
Due date: Exam period
Marks returned: With final results

A practical and theoretical final exam to assess individual competence using finite element analysis to solve simple engineering problems.

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: 7 February - 11 February	Online Activity	Read the course outline; Login and access the course Teams and Moodle pages
Week 1: 14 February - 18 February	Lecture	FE Basics: Introduction to FEA; Discretisation; FE Terminology; Stiffness Matrices for Bars and Trusses; Element Library Introduction
Week 2: 21 February - 25 February	Lecture	Mathematics of FEM: Applying Loads and Boundary Conditions; Assembly; Solving for Nodal Displacements; Constitutive Laws; Interpolation of Stress and Strain
Week 3: 28 February - 4 March	Lecture	Good FE Practice: FE Problem Solving Approach; Assumptions, Mistakes and Errors; Meshing Strategy; Convergence; Validation; Computational Resources; CAD; FE Reporting
Week 4: 7 March - 11 March	Lecture	The Element Library: 2D Triangles and Quads; Shells; 3D Tets and Hexes; Solid Shells; Isoparametric Elements; Quadratic and Higher Order Elements; Choice of Element Types
Week 5: 14 March - 18 March	Lecture	Buckling and Non-linear Analyses: Eigenvalue Solutions; Linear Buckling; Material Non-linearity; Geometric Non-linearity and Buckling; Iteration Scheme and Incremental Analysis; Contact
Week 6: 21 March - 25 March	Fieldwork	3D printing and testing of your design for the group assignment (optional activity)
Week 7: 28 March - 1 April	Lecture	Composite Analysis: Basics of Composites and Composite Mechanics; Modelling Challenges; General Approaches to Modelling Orthotropic and Layered Materials
Week 8: 4 April - 8 April	Lecture	Vibration and Transient Analyses: Modal Analysis; Harmonic Analysis; Other Vibration Solutions; Transient Solutions and their Applications; Choice of Time Discretisation
Week 9: 11 April - 15	Lecture	Industry Guest Lecture: Challenges of modelling

April		complex real-world problems; Determining what level of simplification is appropriate; What to do with results once you have them; Example projects
Week 10: 18 April - 22 April	Lecture	Final Exam Preparation: Tackling a past exam paper

Resources

Prescribed Resources

Microsoft Teams and OneNote

Microsoft's communication platform, Microsoft Teams, will be used for most communication in this course. It has native apps for Windows, Android, iOS and more. OneNote will be used to distribute the class notes (embedded in Teams).

myAccess and Matlab

UNSW myAccess provides access to your engineering software from many different devices. This course will use Matlab extensively, which is available through myAccess, the computer labs and https://www.mathworks.com/academia/tah-portal/university-of-new-south-wales-341489.html

Learning Management System

The Moodle LMS, https://moodle.telt.unsw.edu.au/ will also be used for this course

Recommended Resources

UNSW Library

UNSW Library website: https://www.library.unsw.edu.au/

Suggested textbooks

- Madier, D. (2020) Practical Finite Element Analysis for Mechanical Engineers, 1st Ed, FEA Academy. An electronic version of this book is quite reasonably priced and available at https://www.fea-academy.com/index.php/book-store.
- Chandrupatla, T. R., Belegundu, A. D. (2011) Introduction to Finite Elements in Engineering, 4th Ed, Prentice Hall (Pearson)
- Cook, R. D., Malkus, D. S., Plesha, M. E., Witt, R. J. (2002). Concepts and Applications of Finite Element Analysis, 4th Ed, John Wiley & Sons.

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:

- Introducing a group assignment to smooth your transition into the course.
- Spreading assessments out over the term more evenly.
- Reducing the assessment load to ensure that you have more time.
- Introducing a build and test lab to physically test your design for the group assignment.

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, for a minimum of zero marks.

The late penalty is applied per calendar day (or part thereof), including weekends and public holidays, that the assessment is overdue.

Work submitted after the 'deadline for absolute fail' is not accepted and a mark of zero will be awarded for that assessment item. For example:

- Your course has an assessment task worth a total of **30 marks (Max Possible Mark)**
- You submit the assessment **2 days after the due date**
- The assessment is marked as usual and achieves a score of **20 marks (Awarded Mark)**
- The late policy is applied using **Late Mark = Awarded Mark - (Days*Penalty per Day)*Max Possible Mark**. Your adjusted final score is **8 marks** (20 - ((2*0.2)*30)).

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.

Special Consideration Outcomes

Assessments have default Special Consideration outcomes. The default outcome for the assessment will be advised when you apply for Special Consideration. Below is the list of possible outcomes:

Outcome	Explanation	Example
Time extension	Student provided more time to submit the assessment	e.g. 1 more week of time granted to submit a report
Supplementary assessment	Student provided an alternate assessment at a later date/time	e.g. a supplementary exam is scheduled during the supplementary exam period of the term
Substitute item	The mark for the missed assessment is substituted with the mark of another assessment	e.g. mark for Quiz 1 applied also applied as mark for Quiz 2, meaning if a student achieved a mark of 20/30 for Quiz 1 and was granted Special Consideration for Quiz 2, a mark of 20/30 would be applied for Quiz 2, etc
Exemption	All course marks are recalculated excluding this assessment and its weighting	e.g. The course has an assessment structure of: - Assignments 30%, - Lab report 30%, - Final Exam 40%. If the Lab report is missed and student is granted Special Consideration, then the assessment structure may be reweighted as follows: - Assignments 50% - Final Exam 50% as though the Lab report did not exist
Non-standard	Course Coordinator is contacted for the outcome when special consideration is granted as the outcome differs on a case-by-case basis	e.g. typical for group assessments where time extension supplementary assessment could be granted to the group member, time extension could be granted to the whole group, etc. Clarify with your Course Convenor for

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

****T1-2022 UPDATE****
- -

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. No over-enrolment is allowed in face-to-face classes. Students enrolled in online classes can swap their enrolment from online to 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

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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	