MMAN4410

FINITE ELEMENT METHODS
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1. Staff contact details

Contact details and consultation times for course convenor

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

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

Please see the course Moodle. Demonstrators will be announced closer to semester start.

Consultation hours: 11am-12pm daily during teaching term in the computer lab.

2. Important links

- Moodle
- Lab Access
- Computing Facilities
- Student Resources
- Course Outlines
- Engineering Student Support Services Centre

3. Course details

Credit Points

This is a 6 unit-of-credit (UoC) course which involves 10 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. Thus, for this course, averaged across the 5 weeks of teaching, study and examination periods, you should spend a total of about 30 h/w. The additional 20 h/w 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

<table>
<thead>
<tr>
<th></th>
<th>Day</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures</td>
<td>Monday and Tuesday</td>
<td>9-11am</td>
<td>Ainsworth 204</td>
</tr>
<tr>
<td>Demonstrations/</td>
<td>Wednesday, Thursday and</td>
<td>9-11am</td>
<td>Ainsworth 204</td>
</tr>
<tr>
<td>Computer Lab</td>
<td>Friday</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Note that all classes are in the computer lab. Lecture and demonstration classes won't be clearly delineated.

Summary and Aims 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 and Mechatronic). Any student wishing to extend their structural analysis skills should take this course.

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.

Student learning outcomes

This course is designed to address the learning outcomes below 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:

<table>
<thead>
<tr>
<th>Learning Outcome</th>
<th>EA Stage 1 Competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Apply fundamental finite element analysis techniques to solve simple engineering problems</td>
<td>2.1, 2.2</td>
</tr>
<tr>
<td>2. Explain the underlying mathematics behind finite element analysis software solvers</td>
<td>1.2, 3.2</td>
</tr>
<tr>
<td>3. Plan and execute appropriate finite element analyses to solve a range of solid mechanics and other engineering problems</td>
<td>2.1, 2.2, 2.4, 3.2</td>
</tr>
<tr>
<td>4. Perform a detailed finite element study to investigate a real-world engineering problem</td>
<td>2.1, 2.2, 2.4, 3.2, 3.3</td>
</tr>
</tbody>
</table>

4. 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 face-to-face teaching methods:

1. Lectures to introduce fundamental finite element analysis concepts
2. Software laboratories to apply fundamental concepts in common finite element analysis packages

In addition to the face-to-face teaching, a range of blended techniques will be used through Moodle to engage you with independent learning. The major assignment, for example, includes a significant research component which will allow you to study an engineering problem which is specific to your own interests.

5. Course schedule

The course schedule is shown below. All notes will be provided on Moodle and OneNote.

<table>
<thead>
<tr>
<th>Week</th>
<th>Starting Date</th>
<th>Topic</th>
<th>Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7 Jan</td>
<td>Introduction to FEM and ANSYS</td>
<td>Introduction to FEA; Discretisation; FE Terminology; Stiffness Matrices for Bars and Trusses; Element Library Introduction; Applying Loads and Boundary Conditions; Assembly; Solving for Nodal Displacements; Constitutive Laws; Interpolation of Stress and Strain</td>
</tr>
<tr>
<td>2</td>
<td>14 Jan</td>
<td>Basics of Linear FEM</td>
<td>Different Element Formulations; Benefits and Limitations of Different Element Types; A General FE Problem Solving Approach; Modelling Assumptions; Meshing Strategy; Convergence; Validation; Sources of Error in FE; Computational Resources; Interfacing with CAD; FE Reporting</td>
</tr>
<tr>
<td>3</td>
<td>21 Jan</td>
<td>Nonlinear FEM and Advanced Techniques</td>
<td>Eigenvalue Solutions; Linear Buckling; Material Non-linearity; Geometric Non-linearity and Buckling; Iteration Schema and Incremental Analysis; Contact; Modal Analysis; Harmonic Analysis; Other Vibration Solutions; Transient Solutions and their Applications; Choice of Time Discretisation</td>
</tr>
<tr>
<td>4</td>
<td>29 Jan</td>
<td>Special Topics</td>
<td>Topics may include: Mechanisms and Rigid Dynamics; Modelling Composites; Thermal Analyses; Fluid-Structure Interaction; Magnetostatics; Soil Modelling</td>
</tr>
</tbody>
</table>
### 6. Assessment

**Assessment overview**

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Group Project? (# Students per group)</th>
<th>Length</th>
<th>Weight</th>
<th>Learning outcomes assessed</th>
<th>Assessment criteria</th>
<th>Due date and submission requirements</th>
<th>Deadline for absolute fail</th>
<th>Marks returned</th>
</tr>
</thead>
<tbody>
<tr>
<td>FE Assignment</td>
<td>Yes (4)</td>
<td>20 pages max</td>
<td>20%</td>
<td>1 and 3</td>
<td>Thorough planning and execution, Report writing and communication skills.</td>
<td>Friday 18(^{th}) January</td>
<td>Monday 14(^{th}) January</td>
<td>One week after submission</td>
</tr>
<tr>
<td>Quizzes (2)</td>
<td>No</td>
<td>1 hour each</td>
<td>10%</td>
<td>1 and 2</td>
<td>Correct responses.</td>
<td>Friday 11(^{th}) January</td>
<td>N/A</td>
<td>Following Monday</td>
</tr>
<tr>
<td>Final Theory and Practice Exam</td>
<td>No</td>
<td>3 hours</td>
<td>30%</td>
<td>1, 2 and 3</td>
<td>Fluent use of ANSYS and application of lecture content.</td>
<td>Exam period</td>
<td>N/A</td>
<td>With final results</td>
</tr>
<tr>
<td>Major Project Report and Presentation</td>
<td>Yes (4)</td>
<td>25 pages max and 10 min pres.</td>
<td>40% (30% +10%)</td>
<td>1, 2,3 and 4</td>
<td>Thorough planning and execution; Report writing and communication skills; Creative solution to Engineering problem</td>
<td>Friday 1(^{st}) February Presentation in class</td>
<td>Monday 4(^{th}) February (Report only)</td>
<td>Two weeks after submission</td>
</tr>
</tbody>
</table>

The group assignment will be provided within the first two days of the teaching semester via Moodle and Teams. One submission will be required per group and will be submitted via Moodle. Each member of the group will receive the same mark.

Two quizzes will be completed online in Moodle. The quizzes will be completed outside of class time. A time window will be provided in which the quizzes can be completed.

A 3-hour theory and practice exam will be held in the computer lab and will test a combination of theoretical skills and ANSYS practical skills.

A group major project will be distributed in the first week and will be due on the last teaching day of the course (Friday 1\(^{st}\) Feb). The major report will also be accompanied by a group presentation during the Friday class time (10 mins). One report submission will be required per group accompanied by a peer evaluation form, submitted via Moodle. Each member of the group will receive an individual mark.

Assignments and reports are due at 5pm on the due date, but the submission box will remain open until 11:59 without late penalty. No leniency will be granted for electronic submission difficulties experienced between 5pm and 11:59pm.
Assignments

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.

All formulae, diagrams, graphs, etc. should be electronically generated. No scans or photos of hand-drawn figures will be accepted.

Submission

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of 20% of the maximum mark possible for that assessment item, per calendar day. For instance, consider an assessment item worth a total of 10 marks. If submitted two days late, 4 marks (40%) would be deducted from whatever grade the submission received, down to a minimum of 0 marks. 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:

a. Weekly online tests or laboratory work worth a small proportion of the subject mark,
   or
b. Online quizzes where answers are released to students on completion, or

c. Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date, or

d. Pass/Fail assessment tasks.

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. The final exam for this course will be held during the Summer Term exam period (early February). Please visit myUNSW for Provisional Examination timetable publish dates. For further information on exams, please see the Exams webpage.
For this course, the exam will be open book and will allow limited internet usage as well.

Special consideration and supplementary assessment

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

7. Expected resources for students

Microsoft Teams

Microsoft’s new communication platform, Microsoft Teams, will be used for most communication in this course. It has native apps for Windows, Android, iOS and more.

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 and the computer labs.

Learning Management System

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

UNSW Library

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

8. 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.

Based on previous student feedback, the assessment process for this course has been streamlined and the number of total submissions reduced. Successful elements from other courses (such as Matlab examples) have been incorporated.

This is the first summer offering for MMAN4410, so many activities have had timeframes adjusted to adapted to the intensive mode of teaching. If you have any concerns that elements of the course are not working, please contact Garth immediately and he will endeavour to rectify them.
9. 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](http://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](http://www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf)

10. Administrative matters and links

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
- UNSW Email Address
- Computing Facilities
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Student Equity and Disabilities Unit
- Health and Safety
- Lab Access
- Makerspace
- UNSW Timetable
- UNSW Handbook
- UNSW Mechanical and Manufacturing Engineering
# Appendix A: Engineers Australia (EA) Competencies

## Stage 1 Competencies for Professional Engineers

<table>
<thead>
<tr>
<th>Program Intended Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PE1: Knowledge and Skill Base</strong></td>
</tr>
<tr>
<td>PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals</td>
</tr>
<tr>
<td>PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing</td>
</tr>
<tr>
<td>PE1.3 In-depth understanding of specialist bodies of knowledge</td>
</tr>
<tr>
<td>PE1.4 Discernment of knowledge development and research directions</td>
</tr>
<tr>
<td>PE1.5 Knowledge of engineering design practice</td>
</tr>
<tr>
<td>PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice</td>
</tr>
<tr>
<td><strong>PE2: Engineering Application Ability</strong></td>
</tr>
<tr>
<td>PE2.1 Application of established engineering methods to complex problem solving</td>
</tr>
<tr>
<td>PE2.2 Fluent application of engineering techniques, tools and resources</td>
</tr>
<tr>
<td>PE2.3 Application of systematic engineering synthesis and design processes</td>
</tr>
<tr>
<td>PE2.4 Application of systematic approaches to the conduct and management of engineering projects</td>
</tr>
<tr>
<td><strong>PE3: Professional and Personal Attributes</strong></td>
</tr>
<tr>
<td>PE3.1 Ethical conduct and professional accountability</td>
</tr>
<tr>
<td>PE3.2 Effective oral and written communication (professional and lay domains)</td>
</tr>
<tr>
<td>PE3.3 Creative, innovative and pro-active demeanour</td>
</tr>
<tr>
<td>PE3.4 Professional use and management of information</td>
</tr>
<tr>
<td>PE3.5 Orderly management of self, and professional conduct</td>
</tr>
<tr>
<td>PE3.6 Effective team membership and team leadership</td>
</tr>
</tbody>
</table>