National Centre for Maritime Engineering & Hydrodynamics
Australian Maritime College

JEE350
FINITE ELEMENT ANALYSIS

Semester 2, 2020
Unit Outline

Dr Roberto Ojeda
CONTACT DETAILS

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WHAT IS THE UNIT ABOUT?

Unit description

Finite Element Analysis (JEE350) is an advanced unit that introduces the student to the theory and application of the Finite Element Method in engineering analysis and design.

In addition to learning the theoretical bases of the finite element method the student will also develop his/her applied/practical engineering skills by taking part in a problem based learning activity conducted throughout the semester.

Intended Learning Outcomes

On completion of this unit, you will be able to:

1. Demonstrate knowledge of the theoretical principles and limitations of the finite element method for linear, non-linear, static and dynamic analyses.

2. Develop appropriate and efficient finite element models of a given structure and critically assess the accuracy of the finite element solution.

3. Compare and categorize a set of design options by analysing the results of finite element simulations in order to select the most appropriate configuration.

4. Apply finite element analysis and rapid prototyping techniques in a design project and report the process and outcomes to a professional standard in oral and written form.
Graduate Statement

Successful completion of this unit supports your development of course learning outcomes, which describe what a graduate of a course knows, understands and is able to do. Course learning outcomes are published in the Bachelor of Engineering (Specialisation) with Honours Course Rules. This document is available at http://www.amc.edu.au/ncmeh-course-information.

Course learning outcomes are developed with reference to national discipline standards, Australian Qualifications Framework (AQF), any professional accreditation requirements and the University of Tasmania’s Graduate Statement.

The University of Tasmania experience unlocks the potential of individuals. Our graduates are equipped and inspired to shape and respond to the opportunities and challenges of the future as accomplished communicators, highly regarded professionals and culturally competent citizens in local, national, and global society. University of Tasmania graduates acquire subject and multidisciplinary knowledge and skills, and develop critical and creative literacies and numeracies and skills of inquiry. They demonstrate the ability to apply this knowledge in changing circumstances. Our graduates recognise and critically evaluate issues of social responsibility, ethical conduct and sustainability, are entrepreneurial and creative, and are mindful of their own wellbeing and that of the community. Through respect for diversity and by working in collaborative ways, our graduates reflect the values of the University of Tasmania.

Alterations to the unit as a result of student feedback

None.

Prior knowledge &/or skills

To enrol in this unit you must have successfully achieved the learning outcomes of JEE136 Dynamics and JEE220 Mechanics of Solids (or equivalent units) and you must have been exposed to the content covered in JEE113 Engineering Design and Communication.
HOW WILL I BE ASSESSED?

Assessment schedule

<table>
<thead>
<tr>
<th>Assessment task</th>
<th>Date due</th>
<th>Percent weighting</th>
<th>Links to Intended Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment Task 1</td>
<td>Weeks 4, 6, 7</td>
<td>15% (5% + 5% + 5%)</td>
<td>1, 2</td>
</tr>
<tr>
<td>Assessment Task 2</td>
<td>Weeks 9, 11, 12 &amp; 13</td>
<td>85% (PR1 35% + PR2 30% + PR3 15% + PR4 5%)</td>
<td>1, 2, 3, 4</td>
</tr>
</tbody>
</table>

IMPORTANT NOTE: due to the ongoing changes in restrictions brought about by COVID-19, please be aware that the assessment tasks and requirements for this unit may change. Students will be notified in writing at the earliest opportunity should changes be necessary; please check your emails and/or the MyLO site regularly.

Assessment details

Assessment task 1

Task description

Tutorial Assignments (TUT)
Short submission to assess the progress of the students in attaining the skills required to tackles the major unit assessment. Students are expected to solve simple structural problems using the finite element method and report their findings in short written reports.

Criterion

Criterion 1
Demonstrate a “best-practice” approach in the application of the finite element method to a specific section of the analysis process of a given structural problem by communicating in writing in adherence to defined guidelines.

Measures Intended Learning Outcome:

1, 2

Task length

600 words max

Due date

See assessment schedule
Assessment task 2

<table>
<thead>
<tr>
<th>Task description</th>
<th>FEA Project (PR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The aim of this team project is to design, construct and test a small load bearing structure using the finite element method for the analysis and rapid prototyping for the construction.</td>
<td></td>
</tr>
<tr>
<td>Each team member will design, analyse and report a viable concept. The team will select the best concept and then proceed to refine it. The refined concept will then be manufactured using a 3D printer and then tested to destruction.</td>
<td></td>
</tr>
<tr>
<td>To complete this activity the student will need to work effectively in a team, apply critical thinking, manage his/her time, and prepare/present technical information professionally in a timely manner.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Measures Intended Learning Outcome:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criterion 1</td>
<td>Correctly evaluate the performance of a structure using the finite element method and relevant calculations</td>
</tr>
<tr>
<td>Criterion 2</td>
<td>Demonstrate professional engineering communication skills by writing a complete finite element analysis report in adherence to defined guidelines.</td>
</tr>
<tr>
<td>Criterion 3</td>
<td>Demonstrate knowledge of the theory and applicability of the finite element method by orally presenting and defending the outcomes of a finite element analysis process in front of a technical audience.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task length</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Individual Report (PR1) – 2500 max – 1500 min words (individual mark)</td>
<td></td>
</tr>
<tr>
<td>• Team Report (PR2) - 2500 max - 2000 min words (team mark with peer assessment)</td>
<td></td>
</tr>
<tr>
<td>• Team Presentation (PR3) - 20 minutes (individual mark)</td>
<td></td>
</tr>
<tr>
<td>• Structural Test (PR4) – N/A (team mark)</td>
<td></td>
</tr>
</tbody>
</table>

| Due date | See assessment schedule |

How your final result is determined

Your final result in this unit is determined according to Academic Senate Rule 6 – Admission, Assessment and Student Progress and the College of Sciences and Engineering Procedure for Processing of Results.

To achieve a full pass in this unit, you must meet all the following:

1. Attain all the Intended Learning Outcomes.
2. Achieve an overall mark of 50%.
3. Your mark for your individual report (part of assessment task 2) must be at or above 40%.

You will Fail (NN) the unit if your overall mark is less than 40%.
Submission of assignments

All assignments, reports, etc. must be completed using the template provided on the AMC website, unless otherwise specified by the lecturer. All coursework must have the AMC-NCMEH Assignment Cover Sheet attached which can be downloaded here: http://amc.edu.au/ncmeh-course-information

All assignments and reports must be typed and completed using Word, Excel, approved Engineering drawing software and include the relevant theory, illustrations, results, analysis, and conclusion.

Group reports must be signed by all participants.

Assignments and reports must be placed in the lecturer’s assignment box by the due dates (ground floor in the Swanson Building).

Electronic submissions are not acceptable (unless otherwise instructed by the lecturer). The assessed work will be returned during lecture or as agreed between the students and the lecturer.

Please remember that you are responsible for lodging your coursework on or before the due date. We strongly recommend that you keep a copy; even in the most ‘perfect’ of systems, items sometimes go astray.

Requests for extensions

Extensions will only be granted on medical or compassionate grounds. Requests for extensions should be made via email to the lecturer prior to the due date. Medical certificates or other evidence must be included (electronically or the hard copy mailed) and must contain information which justifies the extension sought.

Penalties

Late assignments which have not been granted an extension will NOT BE ACCEPTED.

Failure to adhere with the WH&S standards whilst taking part in any assessed activity that involves field trips and/or that requires the use of UTAS or AMC facilities will result in the following penalties:

- **first offense**: 5% penalty (applicable to the whole team in team projects);
- **second offense by student (or another member of the same team in team projects)**: 20% penalty (applicable to the whole team in team projects); and
- **third offense**: a fail grade in the assessment.
Review of results and appeals

If you have questions about, or problems with, your assessment you should discuss this with the following people:

(1) The person who marked the assessment.
(2) Unit Coordinator.
(3) Course Coordinator.
(4) Director, NCMEH.

If this does not resolve the issue, you may file a formal review of assessment. The procedure is given at: http://www.utas.edu.au/exams/results

Academic integrity

What is academic integrity?

The University community is committed to upholding the Statement on Academic Integrity. A breach of academic integrity is defined as being when a student:

a) fails to meet the expectations of academic integrity; or
b) seeks to gain, for themselves or for any other person, any academic advantage or advancement to which they or that other person is not entitled; or

c) improperly disadvantages any other member of the University community.

Breaches of academic integrity such as plagiarism, contract cheating, collusion and so on are counter to the fundamental values of the University and can result in a range of penalties. These penalties are outlined in Ordinance 9: Student Academic Integrity.

More information is available from the Academic Integrity for Students webpage.

The University and any persons authorised by the University may submit your assessable works to a text matching service, to obtain a report on possible instances of plagiarism or contract cheating.

Academic Integrity Training Module

As part of the University’s educative approach to academic integrity, there is a short Academic Integrity Training Module that all students are required to complete.

Completion of the module allows you to demonstrate your understanding of what constitutes academic misconduct.

The Academic Integrity Training Module is available for all students through MyLO.

If you do not complete this module your final unit results will be withheld.

You should aim to complete the module within the first few weeks of commencing study at the University.
Academic referencing

In your written work you will need to support your ideas by referring to scholarly literature, works of art and/or inventions. It is important that you understand how to correctly refer to the work of others and maintain academic integrity.

Failure to appropriately acknowledge the ideas of others constitutes a breach of academic integrity, a matter considered by the University of Tasmania as a serious offence.

The appropriate referencing style for this unit is APA 6th.

The University library provides information on presentation of assignments, including referencing styles and should be referred to when completing tasks in this unit.

For further information, see the Academic Integrity for Students webpage.
WHAT LEARNING OPPORTUNITIES ARE THERE?

MyLO

MyLO is the online learning environment at the University of Tasmania. This is the system that will host the online learning materials and activities for this unit.

Getting help with MyLO

It is important that you are able to access and use MyLO as part of your study in this unit. To find out more about the features and functions of MyLO, and to practice using them, visit the Getting Started in MyLO unit.

For access to information about MyLO and a range of step-by-step guides in pdf, word and video format, visit the MyLO Student Support page on the University website.

If something is not working as it should, contact the Service Desk (Service.Desk@utas.edu.au, phone 6226 1818), or Request IT Help Online.

Resources

Required readings

None

Recommended readings


These materials may be useful for developing your knowledge and understanding of the content in this unit, but you are not required to purchase them. When seeking sources of evidence to support your assignment work, you may find these a useful starting point.

Reading Lists

Reading Lists provide direct access to all material on unit reading lists in one place. This includes eReadings and items in Reserve. You can access the Reading List for this unit from the link in MyLO, or by going to the Reading Lists page on the University Library website.
Equipment, materials, software, accounts

**Materials to be provided by the student**
- A non-programmable scientific calculator (Casio fx-82AU PLUS II) is required at all times.
- A4 notebook for tutorial notes, sketches and basic calculations.

**Materials to be provided by AMC**
- Rapid prototyping facility and consumables.
- Test rig.

**Extra costs**
- none

**Computer hardware & software**
- Computational software ANSYS, AutoCAD, Inventor, Rhinoceros are provided for students in the computer labs (Student versions of ANSYS, Inventor and Rhinoceros can be downloaded from the web).
- Microsoft 360, MATLAB and Endnote (these can be downloaded from the Utas website).

**Activities**

**Learning expectations**

The University is committed to high standards of professional conduct in all activities, and holds its commitment and responsibilities to its students as being of paramount importance. Likewise, it holds expectations about the responsibilities students have as they pursue their studies within the special environment the University offers.

Students are expected to participate actively and positively in the teaching/learning environment. They must attend classes when and as required, strive to maintain steady progress within the subject or unit framework, comply with workload expectations, and submit required work on time.

**Details of teaching arrangements**

<table>
<thead>
<tr>
<th>CLASS</th>
<th>DAY</th>
<th>TIME</th>
<th>LOCATION</th>
<th>GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture 1</td>
<td>Monday</td>
<td>14:00-15:00</td>
<td>Collaborate/Recorded</td>
<td>ALL</td>
</tr>
<tr>
<td>Tutorial 1,5</td>
<td>Wednesday</td>
<td>9:00-12:00²</td>
<td>Collaborate</td>
<td>ALL</td>
</tr>
<tr>
<td>Project Q&amp;A</td>
<td>Monday-Friday³</td>
<td>16:00-17:00</td>
<td>Collaborate</td>
<td>ALL</td>
</tr>
<tr>
<td>Project Q&amp;A</td>
<td>Wednesday &amp; Thursday⁴</td>
<td>16:00-17:00</td>
<td>Collaborate</td>
<td>ALL</td>
</tr>
</tbody>
</table>

²except weeks 8 & 13; ³only 1 hour long tutorials from week 9 onwards; ⁴week 8 only; ⁴week 9&11 only; there will be a double tutorial session on week 7.

Check tutorial groups and lab timetable/groups to identify your designated time and day.
## Unit schedule

<table>
<thead>
<tr>
<th>WEEK</th>
<th>DATE BEGINNING</th>
<th>TOPIC/ FOCUS AREA</th>
<th>ACTIVITIES</th>
<th>READINGS/ FURTHER INFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13 July</td>
<td>Introduction</td>
<td>Rhino modelling for ANSYS Workshop</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>20 July</td>
<td>Fundamentals of FEA</td>
<td>Introduction to ANSYS interface/ FEA reporting</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>27 July</td>
<td>Fundamentals of FEA &amp; Beam elements</td>
<td>1D Finite element analysis (links) / Reporting of S and FE models</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>3 August</td>
<td>1D Beam elements</td>
<td>1D Finite element analysis</td>
<td>TUT1</td>
</tr>
<tr>
<td>5</td>
<td>10 August</td>
<td>Special considerations for beam elements</td>
<td>Distributed Load &amp; Self weight</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>17 August</td>
<td>2D elements, meshing and Convergence</td>
<td>Plane Stress and Convergence</td>
<td>TUT2</td>
</tr>
<tr>
<td>7</td>
<td>24 August</td>
<td>3D elements, boundary conditions error + floating structures and buckling</td>
<td>2D &amp; 3D Finite element analysis + Floating Structures &amp; Buckling</td>
<td>TUT3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>7 September</td>
<td>Free</td>
<td>Project Q&amp;A</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>14 September</td>
<td>Introduction to FEA analysis of composite structures and floating structures.</td>
<td>Introduction to FEA analysis of composite structures and floating structures. + Project Q&amp;A</td>
<td>PR1</td>
</tr>
<tr>
<td>10</td>
<td>21 September</td>
<td>Introduction to Non-linear FEA</td>
<td>Introduction to Non-linear FEA + Project Q&amp;A</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>28 September</td>
<td>Dynamic Analysis</td>
<td>Dynamic Analysis</td>
<td>PR2</td>
</tr>
<tr>
<td>12</td>
<td>5 October</td>
<td>Intro to FEA research</td>
<td>Project Presentations</td>
<td>PR3</td>
</tr>
<tr>
<td>13</td>
<td>12 October</td>
<td>Free</td>
<td>Testing</td>
<td>PR4</td>
</tr>
</tbody>
</table>
Topics covered

**Introduction to Finite Element Analysis:** History of the finite element method; Real performance vs. Finite Element Analysis results; Assumptions and limitation of finite element method.

**Analysis Fundamentals:** Review of Theory of Elasticity; Finite element method for solving partial differential equations; One-dimensional and two-dimensional elements applied to stress analysis; Element types, Analysis types.

**Pre-Processing Techniques:** Finite element model vs. Solid model; Meshing techniques and element selection; CAD modelling for finite element analysis; Importing solid models from other applications; Use of primitives and Boolean operations in solid modelling.

**Solution:** Load cases; Boundary conditions; Model checks; Solvers; Hardware resources.

**Post-Processing and interpreting Results:** Validation of results, convergence checks, graphical post-processing.

**Introduction to FE Non-linear analysis:** Sources of non-linear behaviour; Geometric non-linearities and large deflections analysis; Plasticity and Material non-linearities; Contact; Non-linear solution algorithms.

**Introduction to FEA of composite structures:** Layered elements; Orthotropic materials; Failure criteria; Ply orientation.

**Introduction to dynamic applications of the FEM:** Frequency domain vs time domain Analyses. Modal, harmonic and transient simulations. Specific modelling, solution and post-processing considerations dynamics analysis.

Specific attendance/performance requirements

Attendance at all assigned class times is expected. You are responsible for all information (both academic and administrative) presented during class times. Should you miss a class for whatever reason it is your responsibility to obtain information and content that was missed. Attendance at all tutorials, laboratory and practical sessions (including any project work) is compulsory.

In this unit, your active engagement will be monitored in the following way:

1. Attendance to on-line tutorials.
2. Access to MyLO.

If you do not demonstrate evidence of having engaged actively with this unit by completing these two activities by Week 4 of semester, your enrolment may be cancelled or you may be withdrawn from the unit.

Teaching and learning strategies

This unit has been designed to develop you Finite Element Analysis skills by doing. As such it is critical that you engage actively in the tutorial work and your FEA project assignment.
Work Health and Safety (WHS)

The University is committed to providing a safe and secure teaching and learning environment. In addition to specific requirements of this unit you should refer to the University’s Safety and Wellbeing webpage and policy.

Communication

News and announcements may be posted to MyLO News, and students will be expected to be aware of the content of such posts within 48 hours of them being posted.

Students are also expected to check their UTAS email very regularly (once a day) for important announcements.

Concerns and complaints

The University is committed to providing an environment in which any concerns and complaints will be treated seriously, impartially and resolved as quickly as possible. We are also committed to ensuring that a student may lodge a complaint without fear of disadvantage. If you have a concern, information about who to contact for assistance is available on the ‘How to resolve a student complaint’ page.

Learning support

The University provides a range of face-to-face and online services to help equip students with the academic and literacy skills that they need to undertake their study. These services are in addition to the support you receive in each unit from unit coordinators, lecturers and tutors. For details of these additional services such as workshops, individual consultation for learning advice, and peer assisted learning opportunities, please visit https://www.utas.edu.au/students/learning.

The University also provides free access to Studiosity, 24/7 online study help for all UTAS students, enabling them to get feedback on written work within 24 hours or chat live with a subject specialist anywhere and anytime.

All direct assessment-based feedback is provided only from the staff teaching you the unit.

Further information and assistance

More information with regard to content, assessments, grading, GPA etc. is found in the Course Rules Document, available on the AMC website: http://amc.edu.au/ncmeh-course-information

If you are experiencing difficulties with your studies or assignments, have personal or life-planning issues, disability or illness which may affect your course of study, you are advised to raise these with the unit coordinator in the first instance.

In addition to Learning Support, there is a range of University-wide support services available to you including Student Advisers, Disability Services, and more which can be found on the Study Support and Resources and Safety, Health and Wellbeing pages from the Current Students portal of the University website.

Should you require assistance in accessing the Library, visit their website for more information.