Description: Structural Analysis

<table>
<thead>
<tr>
<th>Subject</th>
<th>Cat-nbr</th>
<th>Class</th>
<th>Term</th>
<th>Mode</th>
<th>Units</th>
<th>Campus</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIV</td>
<td>3505</td>
<td>30512</td>
<td>1, 2004</td>
<td>EXT</td>
<td>1.00</td>
<td>TW MBA</td>
</tr>
</tbody>
</table>

**Academic group:** FOENS

**Academic org:** FOES03

**Student contribution band:** 2

**ASCED code:** 030903

**STAFFING**

Examiner: Amar Khennane
Moderator: Graham Baker

**REQUISITES**

Pre-requisite: MEC2402

**SYNOPSIS**

These days the analysis of all but the simple structures is carried out with the aid of computer programmes, in particular the finite element method (FE). The user of the FE method has to decide what kind of elements should be used, and how many of them? Where should the mesh be fine and where may it be coarse? Can the model be simplified? How much physical detail must be represented? Is the behaviour static, dynamic, nonlinear, or what? How accurate will the answers be, and how can they be checked? One need not understand all the mathematics of the finite element to answer these questions. However a competent user must have an understanding of the preliminary mathematics of stress strain and material behaviour, and must be able to understand how elements behave in order to choose suitable kinds, sizes and shapes of elements, and to guard against misinterpretations and unrealistically high expectations. A user must also realise that the FE method is a way of implementing a mathematical theory of physical behaviour. Accordingly, assumptions and limitations of the theory must not be violated by what we ask the software to do. This course is a balanced theoretical and practical introduction to the use of the FE method. The first few chapters will introduce students to new theory essential for competent use of the FE method, for example linear and nonlinear stress and strain definitions, weighted residual methods, finite element approximation. The second part of the course emphasises the behaviour of finite elements and includes computational work in which problems are solved using Matlab and commercial software (MSC Nastran). Students will be provided with a free limited nodes (300) version of this software for the duration of the course. However, they will need to purchase a student version of MATLAB, and a programmable calculator to be used in the exam.
OBJECTIVES

On completion of this course, students should be able to:

- demonstrate a detailed knowledge of linear and non linear stress and strain formulations;
- describe three dimensional isotropic linear elastic analysis;
- apply the principles of the weighted residual methods, virtual work and energy principles;
- explain the concept of finite element approximation;
- apply numerical integration;
- state the principles of the finite element method;
- assess the capabilities and limitations of truss, beam, plane and plate elements;
- write a finite element linear static analysis code in Matlab;
- use a commercial finite element software.

TOPICS

<table>
<thead>
<tr>
<th>Description</th>
<th>Weighting (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mathematical preliminaries</td>
<td>5.00</td>
</tr>
<tr>
<td>2. Linear and nonlinear stress definitions</td>
<td>10.00</td>
</tr>
<tr>
<td>3. Linear and nonlinear strain definitions</td>
<td>10.00</td>
</tr>
<tr>
<td>4. Three-dimensional isotropic linear elastic stress-strain relations</td>
<td>10.00</td>
</tr>
<tr>
<td>5. The basic principles of linear elastic stress-strain relations</td>
<td>5.00</td>
</tr>
<tr>
<td>6. The principles of the weighted residual methods, virtual work and potential energy</td>
<td>10.00</td>
</tr>
<tr>
<td>7. Finite element approximations</td>
<td>10.00</td>
</tr>
<tr>
<td>8. Linear elastic finite element analysis of skeletal structures</td>
<td>10.00</td>
</tr>
<tr>
<td>9. Linear finite element analysis of plane stress and plane strain problems</td>
<td>10.00</td>
</tr>
<tr>
<td>10. Linear elastic analysis of plates</td>
<td>10.00</td>
</tr>
<tr>
<td>11. Introduction to nonlinear problems</td>
<td>10.00</td>
</tr>
</tbody>
</table>

TEXT and MATERIALS required to be PURCHASED or ACCESSED:

ALL textbooks and materials are available for purchase from USQ BOOKSHOP (unless otherwise stated). Orders may be placed via secure internet, free fax 1800642453, phone 07 46312742 (within Australia), or mail. Overseas students should fax +61 7 46311743, or phone +61 7 46312742. For costs, further details, and internet ordering, use the 'Textbook Search' facility at http://bookshop.usq.edu.au click 'Semester', then enter your 'Course Code' (no spaces).

A programmable pocket calculator capable of performing advanced matrix calculations. A student version of Matlab.
REFERENCE MATERIALS:

Reference materials are materials that, if accessed by students, may improve their knowledge and understanding of the material in the course and enrich their learning experience.

On-Line Reference Material:
http://www.jwave.vt.edu/crcd/batra/lectures/esmmse5984/continuumfinal.html ,
http://www.courses.fas.harvard.edu/~es120/handouts/ ,
http://www.math.unl.edu/~tshores/linalgtext.html ,
http://www.ies.co.jp/math/java/misc/lintra/lintra.html ,


(Chapter related to Matrix Stiffness Method)


STUDENT WORKLOAD REQUIREMENTS:

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>HOURS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment</td>
<td>30.00</td>
</tr>
<tr>
<td>Directed Study</td>
<td>52.00</td>
</tr>
<tr>
<td>Examinations</td>
<td>3.00</td>
</tr>
<tr>
<td>Private Study</td>
<td>70.00</td>
</tr>
</tbody>
</table>

ASSESSMENT DETAILS

<table>
<thead>
<tr>
<th>Description</th>
<th>Marks out of</th>
<th>Wtg(%)</th>
<th>Due date</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASSIGNMENT</td>
<td>250.00</td>
<td>25.00</td>
<td>24 May 2004</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(see note 1)</td>
</tr>
<tr>
<td>3 HOUR RESTRICTED</td>
<td>750.00</td>
<td>75.00</td>
<td>END S1</td>
</tr>
<tr>
<td>EXAMINATION</td>
<td></td>
<td></td>
<td>(see note 2)</td>
</tr>
</tbody>
</table>
NOTES:
1. Only assignments that are typed or neatly handwritten in ink will be marked.
2. Student Administration will advise students of the dates of their examinations during the semester.

IMPORTANT ASSESSMENT INFORMATION

1 Attendance requirements:
   There are no attendance requirements for this course. However, it is the students' responsibility to study all material provided to them or required to be accessed by them to maximise their chance of meeting the objectives of the course and to be informed of course-related activities and administration.

2 Requirements for students to complete each assessment item satisfactorily:
   To complete each of the assessment items satisfactorily, students must obtain at least 50% of the marks available (or at least a grade of C-) for each assessment item.

3 Penalties for late submission of required work:
   If students submit assignments after the due date without prior approval then a penalty of 5% of the total marks available for the assignment will apply for each working day late.

4 Requirements for student to be awarded a passing grade in the course:
   To be assured of receiving a passing grade a student must achieve at least 50% of the available weighted marks for the summative assessment items. Students who do not qualify for a Passing grade may, at the discretion of the Examiner, be assigned additional work to demonstrate to the Examiner that they have achieved the required standard. It is expected that such students will have gained at least 45% of the total marks available for all summative assessment items.

5 Method used to combine assessment results to attain final grade:
   The final grades for students will be assigned on the basis of the weighted aggregate of the marks (or grades) obtained for each of the summative assessment items in the course.

6 Examination information:
   In a Restricted Examination, candidates are allowed access to specific materials during the examination. The only materials that candidates may use in the restricted examination for this course are: writing materials (non-electronic and free from material which could give the student an unfair advantage in the examination); a programmable calculator with matrix algebra capabilities (students must indicate on their examination paper the make and model of any calculator(s) they use during the examination).

7 Examination period when Deferred/Supplementary examinations will be held:
   Any Deferred or Supplementary examinations for this course will be held during the examination period at the end of the semester of the next offering of this course.

8 University Regulations:
   Students should read USQ Regulations 5.1 Definitions, 5.6. Assessment, and 5.10 Academic Misconduct for further information and to avoid actions which might contravene University Regulations. These regulations can be found at the URL

ASSESSMENT NOTES

1 The due date for an assignment is the date by which a student must despatch the assignment to the USQ. The onus is on the student to provide proof of the despatch date, if requested by the Examiner.

2 Students must retain a copy of each item submitted for assessment. This must be produced within five days if required by the Examiner.

3 In accordance with University's Assignment Extension Policy (Regulation 5.6.1), the examiner of a course may grant an extension of the due date of an assignment in extenuating circumstances.

4 The Faculty will normally only accept assessments that have been written, typed or printed on paper-based media.

5 The Faculty will NOT accept submission of assignments by facsimile.

6 Students who do not have regular access to postal services or who are otherwise disadvantaged by these regulations may be given special consideration. They should contact the examiner of the course to negotiate such special arrangements.

7 In the event that a due date for an assignment falls on a local public holiday in their area, such as a Show holiday, the due date for the assignment will be the next day. Students are to note on the assignment cover the date of the public holiday for the Examiner's convenience.

8 Students who have undertaken all of the required assessments in a course but who have failed to meet some of the specified objectives of a course within the normally prescribed time may be awarded one of the temporary grades: IM (Incomplete - Make up), IS (Incomplete - Supplementary Examination) or ISM (Incomplete -Supplementary Examination and Make up). A temporary grade will only be awarded when, in the opinion of the examiner, a student will be able to achieve the remaining objectives of the course after a period of non directed personal study.

9 Students who, for medical, family/personal, or employment-related reasons, are unable to complete an assignment or to sit for an examination at the scheduled time may apply to defer an assessment in a course. Such a request must be accompanied by appropriate supporting documentation. One of the following temporary grades may be awarded IDS (Incomplete - Deferred Examination; IDM (Incomplete Deferred Make-up); IDB (Incomplete - Both Deferred Examination and Deferred Make-up).

OTHER REQUIREMENTS

1 Students will require access to e-mail and internet access to USQConnect for this course.