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1. ORGANIZATIONAL COMPONENT

1.1 Introduction

Structural mechanics is concerned with analyzing the effect of external applied loads on structures. Applying the principles of Newtonian mechanics, the resistance of the material to these external loads results in internal reaction forces that cause deformation and displacement within the loaded material.

In this course, we will analyse and understand the stresses and deformations that result from applied loading. We will consider different design and failure criteria, appropriate for each material. This understanding is necessary to design structures for safe and failure free operation.

1.2 General

1.2.1 Teaching philosophy

Lectures will be used to convey fundamental principles and to answer questions. It is expected that the student master the detail of the subject by self-study and practice. In order to achieve this, the homework problems are of great value.

The focus is on understanding rather than on memorisation, which stimulates creative thinking and innovation skills in structural mechanics. It is therefore important to not only ask the question ‘How?’ but also ‘Why?’ Students are encouraged to be able to discern the important global aspects of a problem from the details. For this the underlying theory and principles are very important. Students m

1.2.2 Lecturer and Teaching Assistants

The course will be presented by Dr Helen Inglis.
Office: Engineering 1 - Room 10-21
E-mail: helen.inglis@up.ac.za

The preferred contact method is email, which will be answered within one business day. Please remember that emails are a form of professional communication. In the subject line, include the course code and a descriptive subject. Use appropriate forms of address. Please include your full name and student number.

A number of teaching assistants will be appointed. Their contact details will be published as they are available.
### 1.2.3 Class Schedule

<table>
<thead>
<tr>
<th>Day</th>
<th>Activity</th>
<th>Time</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>Tutorial</td>
<td>13:30 – 15:30</td>
<td>Eng III - 6</td>
</tr>
<tr>
<td>Tuesday</td>
<td>Lecture</td>
<td>09:30 – 10:30</td>
<td>Eng III - 6</td>
</tr>
<tr>
<td>Wednesday</td>
<td>Lecture</td>
<td>11:30 – 12:30</td>
<td>Eng III - 1</td>
</tr>
<tr>
<td>Thursday</td>
<td>Lecture</td>
<td>07:30 – 08:30</td>
<td>Eng III - 6</td>
</tr>
</tbody>
</table>

### 1.2.4 Office Hours

Office hours will be arranged in the first week of classes to be convenient for as many people as possible. If additional consultation is necessary, please schedule via email.

### 1.2.5 Electronic Notice Board

A module for Structural Mechanics (MSY310) will be available on ClickUP. All correspondence and administration will be handled electronically via ClickUP. Students are encouraged to use ClickUP continuously through the semester.

Notes and assignments will be posted on the website and it is expected that students download the relevant material before lectures and tutorials.

### 1.3 Learning activities

#### 1.3.1 Contact Time

The course runs through the 1st semester and there are 3 lectures and 1 two hour tutorial per week for 12 weeks, as shown in the class schedule.

There are 36 lectures during which the relevant principles will be conveyed. It is expected that students attend class regularly and be prepared at all times to participate in class discussions. Students will be expected to read. This is a 16 credit module requiring approximately 160 learning hours. Tutorials offer an opportunity for the students to discuss issues regarding structural mechanics with the lecturer, teaching assistants and classmates.

#### 1.3.2 Pre-class Reading Assignments

Students will be expected to read before coming to class. Reading assignments will be posted on ClickUP, and a quiz assessing the reading must be completed on
ClickUP before class. The purpose of this quiz is to give the lecturer some feedback on the students’ understanding of the material. Students’ participation as well as score on the reading assignment quizzes will contribute to the semester mark.

1.3.3 Homework Assignments

Regular homework assignments will be given to help guide students in their preparation. These homework assignments will not be assessed.

1.3.4 Practical:

The practical will consist of a laboratory session with application to structural mechanics. The practical will contribute to the semester mark.

1.3.5 Tutorial and Class Tests

Occasional tutorial and class tests may be given to assess students’ progress. These will contribute to the semester mark.

1.3.6 Computer Literacy

Since some of the problems in this module are calculation intensive, students will benefit considerably from computer access. A working knowledge of Python or other programming language is required and proficiency with a spreadsheet will also be valuable. Access to a computer and the software mentioned can be obtained from the faculty’s computer laboratory.

1.4 Prescribed Literature

1.3.1 Textbook

“Mechanics of Engineering Materials”
PP Benham, RJ Crawford & CG Armstrong
2nd edition
PEARSON – Prentice Hall

1.3.2 Recommended Textbooks

It is important that students develop skills in structural mechanics, which requires considerable practice. Students may consult other textbooks as sources for more worked examples and exercises. A list of such textbooks will be provided.
1.5 Assessment

1.5.1 Test and Examination

Two semester tests will be written during the semester. The duration of each test will be 90 minutes while the examination will be 180 minutes. No study material or notes will be allowed in tests and exams. No alphanumerical programmable calculators will be allowed in the tests and exams. The necessary information and formulas for the exam will be given during the exam.

1.5.2 Final Mark

The Final mark will be calculated as follows:

<table>
<thead>
<tr>
<th>Mark</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam mark</td>
<td>50%</td>
</tr>
<tr>
<td>Class mark</td>
<td>50%</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>100%</td>
</tr>
</tbody>
</table>

Class mark breakdown:
- Reading assignments: 10%
- Practical: 10%
- Tutorial and class tests: 10%
- Semester Test 1: 35%
- Semester Test 2: 35%

Admission to the Exam:
A student will be admitted to the exam if a semester mark of at least 40% has been achieved.

Pass Requirements:
Passing requires a final mark of at least 50%.

Sick Test:
A sick test will be granted to students who qualify for such a test. It is the responsibility of the student to apply for such test according to the procedure stipulated in the departmental study guide. Only one sick test, on all the work covered up to the lecture before the sick test, will be given. The test will be written after the second semester test.

1.6 Departmental study guide

This study guide is a crucial part of the general study guide of the Department. In the study guide of the Department, information is given on the mission and vision of the department, general administration and regulations (professionalism and integrity, course related information and formal communication, workshop use and safety,
plagiarism, class representative duties, sick test and sick exam guidelines, vacation work, appeal process and adjustment of marks, university regulations, frequently asked questions), ECSA outcomes and ECSA exit level outcomes, ECSA knowledge areas, CDIO, new curriculum and assessment of cognitive levels. It is expected that you are very familiar with the content of the Departmental Study Guide. It is available in English and Afrikaans on the Department’s website.

**English:**
http://www.up.ac.za/media/shared/120/Noticeboard/departmental-studyguide-eng-2016.zp77597.pdf

**Afrikaans:**
http://www.up.ac.za/media/shared/120/Noticeboard/departementele-studiegids-afr-2016.zp77599.pdf

Take note of the specific instructions in the above study guide on:

- a. Safety
- b. Plagiarism
- c. What to do if you were sick (very important)?
- d. Appeal process on the adjustment of marks
2. STUDY COMPONENT

2.1 General Objectives

The effective application of structural mechanics is somehow or another relevant to most engineering disciplines. Structural Mechanics is concerned with analysing the effects of applied loads on and in bodies. In this module the student will primarily study the following:

- The stress and strain relationships in a material.
- The failure and fracture of materials.
- The mechanics of various structural members under applied loading.
- This theory in turn equips the student to design:
  - Against displacements limits;
  - Against stress limits;
  - For fracture strength, and
  - With consideration of material properties.

2.2 Prerequisite Learning

Machine design (MOW 227), Differential Equations (WTW 256). Structural Mechanics (MSY310) is the extension of these courses in the sense that it provides a student in more depth with the analysis of internal behaviour of materials under external loading using mathematical and physical principles.
### 2.3 Study Themes

<table>
<thead>
<tr>
<th>Study Theme</th>
<th>Contact sessions</th>
<th>Total study hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statically determinate force systems</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Statically determinate stress systems</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Stress-Strain relations</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Statically indeterminate stress systems</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Torsion</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Bending</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Stress</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>- Slope and deflection</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Statically indeterminate beams</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Energy Methods</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Buckling instability</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Stress and strain transformations</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Yield Criteria and stress concentration</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Elementary plasticity</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Fracture mechanics</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Fatigue</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Variation of stress and strain</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Thick walled cylinder theory</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>40</strong></td>
<td><strong>160</strong></td>
</tr>
</tbody>
</table>

*Total include: contact sessions, self-study and preparation for tests and exams

Study theme descriptions will be made available as the module progresses.
2.4 Test and Exam Assessment

The assessment of all the tests for this course will be done with a Mark allocation as shown in the table below. The student has to achieve a minimum of 50% of marks listed in the table below for a pass requirement. This assessment has as its aim the testing of whether the student has reached the exit level of outcome 1 of ECSA.

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Mark allocation out of 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>The student identifies the type of loading on the structure (axial, torsion or lateral) and uses the appropriate method to obtain stresses, strains, deflations etc. Stating the appropriate assumptions.</td>
<td>1</td>
</tr>
<tr>
<td>Free body diagram. Calculation of reaction forces and moments. Diagram of internal forces throughout the structure (shear, moment, axial and torque diagrams).</td>
<td>2</td>
</tr>
<tr>
<td>The design (sizing) of the structure can be based on multiple criterions such as limiting normal and shear stress and strain, deflection and creep limitations as defined in the problem. The student identifies the number of correct applicable analysis’s to obtain the solution to each of the criterion.</td>
<td>2</td>
</tr>
<tr>
<td>Presenting solutions according to each criterion (limited normal or shear stress, deflection, strain, creep, etc.).</td>
<td>2</td>
</tr>
<tr>
<td>If multiple criterions are necessary to solve the problem but there is only one correct solution, the student must present the solutions that satisfy each individual criterion and then outline the correct one with an explanation.</td>
<td>2</td>
</tr>
<tr>
<td>Solution presented with correct symbols and units.</td>
<td>1</td>
</tr>
</tbody>
</table>