UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Engineering, Built Environment and Information Technology

Fakulteit Ingenieurswese, Bou-omgewing en Inligtingtegnologie

School of Engineering / Skool vir Ingenieurswese

Department of Mechanical & Aeronautical Engineering / Meganiese- en Lugvaartkundige Ingenieurswese

Structural Mechanics – MSY 310

Lecturer: Dr Helen Inglis
Last Revision: 1 February 2017

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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.

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

Monday	Tutorial	13:30 – 15:30	Eng III - 6
Tuesday	Lecture	09:30 – 10:30	Eng III - 6
Wednesday	Lecture	11:30 – 12:30	Eng III - 1
Thursday	Lecture	07:30 – 08:30	Eng III - 6

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. Tutorials offer an opportunity for the students to discuss issues regarding structural mechanics with the lecturer, teaching assistants and classmates. This is a 16 credit module requiring approximately 160 learning hours. Students should therefore be spending approximately eight hours per week working on the module besides the time spent in class. These hours could be spent preparing for class; reviewing class notes; working through the textbook; completing homeworks and projects.

1.3.2 Homework Assignments

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

1.3.3 Practical:

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

1.3.4 Tutorial and Class Tests

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

1.3.5 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 Course Literature

1.4.1 Prescribed Textbook

Gere, JM and Goodno, BJ, "Mechanics of Materials", 8th SI edition, Cengage Learning, 2013. ISBN 978-1-111-57774-2.

1.4.2 Recommended Textbooks

Budynas, RG and Nesbitt, KJ, "Shigley's Mechanical Engineering Design", 10th edition, McGraw-Hill, 2014.

1.4.3 Course Notes

Occasional course notes will be published on ClickUP where necessary. It is the student's responsibility to download these notes.

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.

This is an exit level module for **ECSA Outcome 1: Problem Solving**.
Learning outcome: Demonstrate competence to identify, assess, formulate and solve convergent and divergent engineering problems creatively and innovatively.
Associated Assessment Criteria: The candidate applies in a number of varied instances, a systematic problem solving method including:

1. Analyses and defines the problem, identifies the criteria for an acceptable solution;
2. Identifies necessary information and applicable engineering and other knowledge and skills;
3. Generates and formulates possible approaches to solution of problem;
4. Models and analyses possible solution(s);
5. Evaluates possible solutions and selects best solution;
6. Formulates and presents the solution in an appropriate form.

Range Statement: Problems requires identification and analysis. Some cases occur in unfamiliar contexts. Problems are both concrete and abstract and may involve uncertainty. Solutions are based on theory and evidence, together with judgement where necessary.

A number of problems in both semester tests and the final examination will be assessed with a rubric based on the ECSA problem solving requirement. In order for a student to pass the module, it is necessary that they attain a mark of at least 50% on this component of the assessment.

1.5.2 Final Mark

The Final mark will be calculated as follows:

Exam mark	50%
Class mark	50%
TOTAL:	**100%**

Class mark breakdown:

Practical	15%
Tutorial and class tests	15%
Semester Test 1	35%
Semester Test 2	35%

Practical:

The practical will consist of a laboratory session with application to structural mechanics. A mark for the practical of at least 40% is required to be admitted to the exam.

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

Pass Requirements:
Passing requires a final mark of at least 50%, and a subminimum of 50% on the ECSA problem solving rubric.

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/2017/departmental-studyguide-eng-2017.zp107056.pdf

Afrikaans:
http://www.up.ac.za/media/shared/120/Noticeboard/2017/departementele-studiegids-afr-2017.zp107058.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 mechanics of various structural members under applied loading.
- The failure and fracture of materials.
- 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. The internal behaviour (stress and strain states) of materials under external loading will be analysed using mathematical and physical principles.

2.3 Study Themes

Study Theme	Contact sessions	Total study hours
ANALYSIS OF STRESSES AND STRAINS IN STRUCTURES		
Stress-strain relations	3	12
Specialised states of stress and strain (1D simplification, plane stress, plane strain)	1	6
Stress and strain transformations	2	8
Experimental strain measurements	1	4
Strain energy density	1	4
Statically determinate systems • Thin-walled pressure vessel • Review of Axial bar: FBD, distributed stress, energy, stress concentrations, St Venant	2	10
Statically indeterminate systems • What makes a system statically indeterminate? • Solution strategies for statically indeterminate systems • (Case studies: axial bar problems)	2	8
Torsion	2	12
Bending of statically determinate beams • SF/BM diagrams using integral method • Derivation of Euler-Bernoulli beam equations – stress in beam • Shear stresses, shear flow, shear centre • Composite beams • Slope and deflection of beams • Castigliano's theorem	7	32
Statically indeterminate beams	2	8
Total for analysis of stress and strain	**23**	**104**
FAILURE CRITERIA		
Buckling instability	3	14
Ductile failure • Yield criteria (Tresca, von Mises) • Elementary elastoplastic analysis for beams	4	16
Brittle failure: Fracture mechanics	3	14
Fatigue • Rainflow counting • Mechanistic Fatigue: Fatigue crack propagation	3	12
Total for failure criteria	**13**	**56**
Total	36	160

** Total* includes: contact sessions, self-study and homework