UNSW AUSTRALIA

Course Outline

Semester 1, 2015

Never Stand Still | Faculty of Engineering | School of Mechanical and Manufacturing Engineering

MMAN2400

Mechanics of Solids 1

CONTENTS

prepared by G Prusty, Feb 2015

1. YOUR COURSE AT A GLANCE

Mechanics of Solids 1(MMAN 2400)

Notes	Section	Assessed activities
• Equilibrium of deformable bodies, internal forces or stress resultants • Normal and shear stress and strain • Mechanical properties of materials; Hooke's law, St Venant principle, Poisson ratio, strain energy • Stresses and deformations of axially loaded members	Block 1 Revision of Statics and more	Adaptive Tutorial Exercise 1 Mechanics Fundamentals Launch (Wk1) Due (Wk3) *Block test 1 (Wk 4, 27/3/2015 3-4 pm)
• Stresses and deformations in torsion of circular shafts; helical springs • Bending of beams – *Shear* force and bending *Moment* diagrams • Flexural and Shear stresses in a straight beam • Slope and displacement of beams by various methods	Block 2 Basics of Stress and Strain	Adaptive Tutorial Exercise 2 Torsion, SF & BM Launch (Wk4), Due (Wk 6) Lab experiments (Deflection, Torsion) Lab assignment submission(Deflection, Torsion) due (Wk 6, 17/4/2015) *Block test 2 (Wk 8, 1/5/2015 3-4 pm)
• Stresses and deformations of thin-walled cylindrical pressure vessels • Combined stresses; variation of stress at a point in two and three dimensions • Strain transformations in two dimension; strain gauges, generalized Hooke's law	Block 3 2 D & 3D Stresses, Strains and applications	Adaptive Tutorial Exercise 3 2D & 3D Mohr's Circle Launch (Wk7) Due (Wk10) Laboratory experiments (Fatigue, Beam Stress) *Block test 3 (Wk10, 15/5/2015 3-4 pm)
• Strain energy in a linearly elastic body, Displacements by energy methods • Theories of failure- Criteria under static loading • Theories of failure- Criteria under repetitive loading; • Stress concentrations	Block 4 Energy Methods, Yield Criteria, Repetitive Loading	Adaptive Tutorial Exercise 4 Design for components Launch (Wk11) Due (Wk13) Lab assignment submission(Fatigue, Beam Stress) due (Wk12, 29/5/2015) *Block test 4 (Wk13, 5/6/2015 3-4 pm)
FINAL EXAM		

* Venue for the block tests will be notified through Moodle

2. COURSE STAFF

Course convenor

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3. COURSE INFORMATION

Details

This is a second year undergraduate course, worth 6 Units of credit

Nominal total student time: 11 hours per week, including 6 hours per week class contact time.

Course Objectives

The first objective of this course is to study the relationships between the *external* loads applied to deformable body and the intensity of *internal* forces or *stresses* acting within the body. It also involves the study of deformations or *strains* caused by external loads.

Based on linear elastic material behaviour you will be given sufficient understanding of the relationships between stress and strain in two and three dimensions.

The yield criteria for static loading and fatigue and fracture under repetitive loading will be covered to enable you to design structures, machines and components.

How this course is related to other courses and relevant program(s)

This course builds on the statics component of MMAN1300 Engineering Mechanics 1, and some of the concepts from that course are amplified here.

This course, together with its successor, MMAN3400 Mechanics of Solids 2, provide the foundations for subsequent structural design courses MECH3110 Mechanical Design 1, MECH4100 Mechanical Design 2, AERO4410 Advanced Aerospace Structures and Vibrations and NAVL4410 Ship Structures 2.

Expected student learning outcomes

Learning outcome	UNSW graduate Attributes[1]
Recognise the fundamentals of Solid Mechanics.	2,3,4
Demonstrate the fundamentals of stresses and strains	2,3,4
Identify and express the principles of Solid Mechanics in obtaining the solutions for applications in real life engineering problems.	2,3,4
Demonstrate and apply the fundamentals of Solid Mechanics in selecting suitable materials in engineering applications.	1,2,3,4,11
Create and Develop “engineers’ eyes”	2

Learning and teaching philosophy

You will learn best when you are doing something, so this course is designed to keep you active, even in lectures. The classic learning activity in mechanics of solids is the tutorial problem and you will have plenty of these, in various forms.

UNSW expects 25-30 hours of student time per Unit of Credit spread across all the learning opportunities listed above. For MMAN2400 (6UoC) this means roughly:

In class	6 hours per week
Self-study	5 hours per week
TOTAL	11 hours per week

Use this as a guide. You might need more self-study (or possibly less) depending upon your previous studies and aptitudes and the grade you are aiming for.

4. TEACHING STRATEGIES

Component	Activities
Lectures	• Find out what you must learn • See methods that are not in the textbook • Follow worked examples • Hear announcements on course changes

[1] http://www.ltu.unsw.edu.au/ref4-4-1-1_unsw_grad_atts.cfm

Problem Solving Class	• Be guided by course notes and demonstrators • Ask questions • Do problems, as set out in the course notes • Study an aspect of mechanics of solids • Work with colleagues
Private study (including Moodle)	• Review lecture material and textbook • Do set problems and assignments • Discuss with friends • Adaptive Tutorials • Join Moodle discussions of problems • Download materials from Moodle • Keep up with notices and find out marks via Moodle
Assessments (Block Tests, Adaptive Tutorials, Laboratories and Final Exam)	• Demonstrate your basic knowledge and skills • Learn from feedback • Demonstrate higher understanding and problem solving

5. ASSESSMENT

Reasons

We need to find out how well you have:

- grasped the fundamentals of stress and strains
- become proficient in developing an understanding for engineering applications
- become proficient in calculation layout and development
- developed correct, professional technique
- become proficient in using solid mechanics fundamentals to solve practical problems
- come to see the world through “engineers’ eyes”
- prepared yourself for higher structural engineering courses.

Scheme

Assessment is based on the blocks shown on p3 and p7. Basic knowledge is assessed after each one. Marks are awarded as shown next page.

Type of Assessment	Basic marks and weighting	Reason for assessment
Block tests 1-4	4x7=28	Four tests to assess basic knowledge
Laboratory assignments	Torsion = 5 Deflection = 6 Beam Stress = 4 Fatigue = 4	checking the “doing” in “learning by doing”

Adaptive Tutorials • Mechanics Fundamentals • Torsion • SF & BM • 2D & 3D-Mohr's circle • Deign of Components	Total marks 13: 3 1 3 3 3	To further enhance your learning abilities beyond normal contact hours
Exam (written questions covering the whole course)	40	Final exam provide an opportunity to assess higher capabilities
	Course Total 100	

Assessment Criteria

Block Tests and Final examination:

- Use the basic concepts such as Free Body Diagrams (FBD) and Equations of Equilibrium (EoE)
- Systematic approach to outline the steps for a problem and use the necessary fundamental concepts covered in the lectures and tutorials
- Correctness of the solution with the aid of necessary diagrams/sketches and the use of appropriate units.

Laboratory Reports:

- Interpretation of the experimental results for the required information described in the hand out for each experiment
- Understanding the relationship between the theory covered during the lectures to experimental results in the laboratory
- Presentation of report in accordance with the MECHENG guidelines
- Attendance and participation during the laboratory experiments.

eLearning exercise:

- Demonstrating the basic understanding of the concepts for each exercise while working out the given examples
- Number of attempts taken to arrive at the correct solution.
- Correctness of the solution with the use of appropriate sign, magnitude & units.

A pass in this course requires a mark of 50%.

Presentation requirements

All submissions should have a standard School cover sheet which is available from the School website and this subject's Moodle page. All submissions are expected to be neat, and clearly set out. All calculations should be shown as, in the event of incorrect answers, marks are awarded for method and understanding.

The preferred set-out of any numerical calculation is similar to the following:

$A_{bow} = 0.0035AmfV$ (Equation in symbols)
$= 0.0035 \times 480 \times 0.95 \times 1.0 \times 18.00$ (Numbers substituted)
$= 28.7\ m^2$ (Answer with units)

Completing assessed work

Inability to attend the block tests on one of these times for reasons such as work commitments, holidays etc. cannot, unfortunately, be accommodated with a class of this size. Of course arrangements will be made for emergencies such as illness. Arrangements for each type of assessment are tabulated below.

Type of Assessment	
Block tests 1-4	Repeat test only for illness and other emergencies
Adaptive Tutorial exercise	Online submission
Laboratory	Reports submission via school assignment boxes
Final Examination	Standard UNSW arrangements

Late submissions will receive 10% penalty per calendar day. An extension may only be granted in exceptional circumstances. Where an assessment task is worth less than 20% of the total course mark and you have a compelling reason for being unable to submit your work on time, you must seek approval for an extension from the course convenor ***before the due date***. Special consideration for assessment tasks of 20% or greater must be processed through https://student.unsw.edu.au/special-consideration.

It is always worth submitting late assessment tasks when possible. Completion of the work, even late, may be taken into account in cases of special consideration.

6. ACADEMIC HONESTY AND PLAGIARISM

Plagiarism is using the words or ideas of others and presenting them 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 booklet which provides essential information for avoiding plagiarism: https://my.unsw.edu.au/student/academiclife/Plagiarism.pdf

There is a range of resources to support students to avoid 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. Information is available on the dedicated website Plagiarism and Academic Integrity website: http://www.lc.unsw.edu.au/plagiarism/index.html

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:
http://www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Further information on School policy and procedures in the event of plagiarism is presented in a School handout, Administrative Matters for All Courses, available on the School website.

7. COURSE SCHEDULE

Basic structure

Three hours lectures, one hour problem solving class and two hours of tutorial per week; five hours of self-study.

Detailed listing

See p8 for a week-by-week listing of class activities.

8. RESOURCES FOR STUDENTS

Available through the UNSW bookshop:

Hibbeler, Mechanics of Materials SI 9th edition and Prusty, Mechanics of Solids 1, PRENTICE-HALL *(ISBN:* 9781486025091*)*

Moodle site for MMAN 2400 Mechanics of Solids 1. Access via
https://moodle.telt.unsw.edu.au/login

School study guide

(2006) *The Guide to studying in the School of Mechanical and Manufacturing Engineering*, School of Mechanical and Manufacturing Engineering. UNSW. School's website www.mech.unsw.edu.au

Library (e.g. http://info.library.unsw.edu.au/web/services/services.html)

9. COURSE EVALUATION AND IMPROVEMENT

Feedback on the course is gathered periodically using various means, including the Course and Teaching Evaluation and Improvement (CATEI) process, informal discussion in the final tutorial 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.

10. ADMINISTRATIVE MATTERS

You are expected to have read and be familiar with "Administrative Matters", available on the School website. This document contains important information on student responsibilities and support, including special consideration, assessment, health and safety, and student equity and diversity.

Planned Schedule (subject to updating)

The schedule below is broken into blocks (see p2) so you can grasp the content of solid mechanics in manageable chunks. The general format for each block is:

- Three weeks of concentrated lectures and problem solving classes,
- tutorials
- laboratories
- test of basic material (Block Tests & Adaptive Tutorial exercises)

In the UNSW examination week, the MMAN2400 exam will include more questions covering the whole course.

Week	3hrs Lecture + 1 hr problem solving	2 hrs Tutorial	Section of Student Package	Text book by R. C. Hibbeler
1	Equilibrium of deformable bodies, internal forces or stress resultants		Chapter 1	Sections 1.2, 1.3, 1.5, 3.2, 3.5, 3.6 &4.1
2	Normal and shear stress and strain	General	Chapter 1	Section 2.2
3	Mechanical properties of materials; Hooke's law, St Venant principle, Poisson ratio, strain energy. Stresses and deformations of axially loaded members **BLOCK TEST 1**	General	Chapter 2	Sections 1.5, 1.6, 4.2, 4.4 & 4.6
4	Stresses and deformations in torsion of circular shafts; helical springs	General	Chapter 3	Sections 5.1, 5.2, 5.3, 5.4 & 5.5
5	Bending of beams – *Shear* force and bending *Moment* diagrams, Flexural and Shear Stresses in a straight beam	General	Chapters 4 & 5	Sections 6.1, 6.2, 6.3 & 6.4. Sections 7.1,7.2 &7.3
6	Slope and displacement of beams by various methods **BLOCK TEST 2**	General	Chapter 6	Sections 12.1, 12.2 & 12.3
7	Stresses and deformations of thin-walled cylindrical pressure vessels	General	Chapter 7	Section 8.1
8	Combined stresses; variation of stress at a point in two and three dimensions	General	Chapter 8	Sections 9.1, 9.2, 9.3, 9.4 & 9.7
9/10	Strain transformations in two and three dimensions, strain gauges, generalized Hooke's law **BLOCK TEST 3**	General	Chapter 9	Sections 10.1, 10.2, 10.3, 10.4, 10.5 & 10.6
11	Strain energy in a linearly elastic body, Displacements by energy methods	General	Chapter 10	Sections 14.1, 14.2, 14.3 & 14.8
12	Theories of Failure-Criteria under static and *repetitive loading, *stress concentrations	General	Chapters 11, 12	Section 10.7 *Topic is not available in Hibbeler
13	**BLOCK TEST 4**	General		
Exam	More questions!!!!			

G Prusty Feb 2015