UNSW AUSTRALIA

Course Outline

Semester 1, 2016

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

MMAN2400

Mechanics of Solids 1

Contents

prepared by G Prusty, Feb 2016

1. Staff Contact Details

Contact details and consultation times for course convenors

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Contact details and consultation times for additional lecturers/demonstrators/lab staff

Consultation concerning this course is available by email or in person. For an in-person appointment, please contact a convenor by email to arrange.

2. Course details

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.

Aims of the Course

The aim 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.

Contact Hours

	Day	Time	Location
Lectures	Tuesday	12- 2p.m.	J17 Ainsworth G03 (weeks 1 – 12)
	Friday	2-4 p.m.	
Problem Solving Session (PSS)	2 Hr slot as selected by student		

Student learning outcomes

This course is designed to address the below learning outcomes and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers as shown. The full list of Stage 1 Competency Standards may be found in Appendix A.

After successfully completing this course, you should be able to:

Learning Outcome		**EA Stage 1 Competencies**
LC1.	Recognise the fundamentals of Solid Mechanics	PE1.1, 1.2
LC2.	Demonstrate the fundamentals of stresses and strains	PE1.3
LC3.	Identify and express the principles of Solid Mechanics in obtaining the solutions for applications in real life engineering problems	PE1.3
LC4.	Demonstrate and apply the fundamentals of Solid Mechanics in selecting suitable materials in engineering applications	PE1.3
LC5.	Create and Develop “engineers’ eyes”	PE2.1, 2.2, 2.3

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
TOTAL11 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.

Summary of the course*

Week	2 x 24hrs Lecture	2 hrs PSS	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!!!!			

* Topics during the weekly teaching format might be varied or changed

3. 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
Problem Solving Session	• 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

4. Course schedule

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 (Wk 1) Due (Wk 3) *Block test 1 (Wk 4, 22/3/2016, 1-2 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 (Wk 4), Due (Wk 6) Lab experiments (Deflection and Torsion in Wk 3, 4 and 5) Lab assignment submission(Deflection, Torsion) due (Wk 6) *Block test 2 (Wk 7, 22/4/2016, 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, generalised Hooke's law	Block 3 2 D & 3D Stresses, Strains and applications	Adaptive Tutorial Exercise 3 2D & 3D Mohr's Circle Launch (Wk 7) Due (Wk 10) Laboratory experiments (Fatigue and Beam Stress in Wk 8, 9 and 10) *Block test 3 (Wk 10, 13/5/2016, 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 (Wk 11) Due (Wk 13) Lab assignment submission(Fatigue, Beam Stress) due (Wk 11) *Block test 4 (Wk 13, 3/6/2016, 3-4 pm)
FINAL EXAM		

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”
- prepare 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	Learning outcomes assessed	Due date	Marks returned
Block tests 1		4x7=28	Four tests to assess basic knowledge	LC1, 2	22/3/2016 (Wk 4)	Week 5
Block tests 2				LC1, 2, 3	22/4/2016 (Wk 7)	Week 8
Block tests 3				LC2, 3	13/5/2016 (Wk 10)	Week 11
Block tests 4				LC2, 3, 4	3/6/2016 (Wk 13)	Study period
Laboratory assignments		Torsion = 5	checking the “doing” in “learning by doing”	LC1, 2	Week 6	Week 8
		Deflection = 6		LC1, 2	Week 6	Week 8
		Beam Stress = 4		LC2, 3	Week 11	Week 13
		Fatigue = 4		LC2, 3, 4	Week 11	Week 13
Adaptive Tutorials	Mechanics Fundamentals	3	To further enhance your learning abilities beyond normal contact hours	LC1, 2	Week 3	Automated marking
	Torsion	1		LC1, 2	Week 6	
	SF & BM	3		LC1, 2	Week 6	
	2D & 3D-Mohr’s circle	3		LC3, 4	Week 10	
	Deign of Components	3		LC3, 4, 5	Week 13	

Exam (written questions covering the whole course)	40	Final exam provide an opportunity to assess higher capabilities	LC1, 2, 3, 4, 5	During exam period (date TBC)	During release of results
	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 problem solving sessions.
- 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% in assessments and final examination.

Presentation requirements

All submissions should have a standard School cover sheet which is available from this course'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 be penalised 5 marks per calendar day (including weekends). 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.

You must be available for all tests and examinations. Final examinations for each course are held during the University examination periods, which are June for Semester 1 and November for Semester 2. Provisional Examination timetables are generally published on myUNSW in May for Semester 1 and September for Semester 2

For further information on exams, please see the Exams section on the intranet.

Calculators

You will need to provide your own calculator, of a make and model approved by UNSW, for the examinations. The list of approved calculators is shown at student.unsw.edu.au/exam-approved-calculators-and-computers

It is your responsibility to ensure that your calculator is of an approved make and model, and to obtain an “Approved” sticker for it from the School Office or the Engineering Student Centre prior to the examination. Calculators not bearing an “Approved” sticker will not be allowed into the examination room.

Special Consideration and Supplementary Assessment

For details of applying for special consideration and conditions for the award of supplementary assessment, see the School intranet, and the information on UNSW’s Special Consideration page.

6. Expected 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

Other Resources

If you wish to explore any of the lecture topics in more depth, then other resources are available and assistance may be obtained from the UNSW Library: https://www.library.unsw.edu.au/servicesfor/index.html

7. Course evaluation and development

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 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.

Feedback from a previous instance of the course suggested that a large number of small assessment tasks were conducive to accumulating knowledge in mechanics of solids. Few suggestions were raised from the previous year with regards to instructions in the lab handout. Recent improvements to the course as a response to student feedback include:

- Providing clear instructions in the lab handouts for what to be assessed.
- Changing report submission date to return reports with feedback to students prior to the study period.

You are greatly encouraged to provide feedback on all aspects of the course using email and the discussion forum within Moodle.

8. Academic honesty and plagiarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off 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 website with a wealth of resources to support students to understand and avoid plagiarism: https://student.unsw.edu.au/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.

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 available on the intranet.

9. Administrative Matters

All students are expected to read and be familiar with School guidelines and polices, available on the intranet. In particular, students should be familiar with the following:

- Attendance, Participation and Class Etiquette
- UNSW Email Address
- Computing Facilities
- Assessment Matters (including guidelines for assignments, exams and special consideration)
- Academic Honesty and Plagiarism
- Student Equity and Disabilities Unit
- Health and Safety
- Student Support Services

Gangadhara Prusty
3rd Feb 2016

Appendix A: Engineers Australia (EA) Professional Engineer Competency Standards

	Program Intended Learning Outcomes
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing
	PE1.3 In-depth understanding of specialist bodies of knowledge
	PE1.4 Discernment of knowledge development and research directions
	PE1.5 Knowledge of engineering design practice
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice
PE2: Engineering Application Ability	PE2.1 Application of established engineering methods to complex problem solving
	PE2.2 Fluent application of engineering techniques, tools and resources
	PE2.3 Application of systematic engineering synthesis and design processes
	PE2.4 Application of systematic approaches to the conduct and management of engineering projects
PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability
	PE3.2 Effective oral and written communication (professional and lay domains)
	PE3.3 Creative, innovative and pro-active demeanour
	PE3.4 Professional use and management of information
	PE3.5 Orderly management of self, and professional conduct
	PE3.6 Effective team membership and team leadership