MMAN2400

Mechanics of Solids 1
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prepared by  G Prusty, Feb 2015
### 1. Your Course at a Glance

**Mechanics of Solids 1 (MMAN 2400)**

<table>
<thead>
<tr>
<th>Notes</th>
<th>Section</th>
<th>Assessed activities</th>
</tr>
</thead>
</table>
| Equilibrium of deformable bodies, internal forces or stress resultants | **Block 1** Revision of Statics and more | Adaptive Tutorial Exercise 1
Mechanics Fundamentals
Launch (Wk1)
Due (Wk3) |
| Normal and shear stress and strain         |                                      | *Block test 1 (Wk 4, 27/3/2015 3-4 pm)                                               |
| Mechanical properties of materials; Hooke’s law, St Venant principle, Poisson ratio, strain energy |                                      |                                                                                      |
| Stresses and deformations of axially loaded members |                                      |                                                                                      |

| Stresses and deformations in torsion of circular shafts; helical springs | **Block 2** Basics of Stress and Strain | Adaptive Tutorial Exercise 2
Torsion, SF & BM
Launch (Wk4), Due (Wk 6) |
| Bending of beams – Shear force and bending Moment diagrams |                                      | Lab experiments (Deflection, Torsion)                                                |
| Flexural and Shear stresses in a straight beam |                                      | Lab assignment submission(Deflection, Torsion) due (Wk 6, 17/4/2015)                  |
| Slope and displacement of beams by various methods |                                      | *Block test 2 (Wk 8, 1/5/2015 3-4 pm)                                                |

| Stresses and deformations of thin-walled cylindrical pressure vessels | **Block 3** 2 D & 3D Stresses, Strains, and applications | Adaptive Tutorial Exercise 3
2D & 3D Mohr’s Circle
Launch (Wk7)
Due (Wk10) |
| Combined stresses; variation of stress at a point in two and three dimensions |                                      | Laboratory experiments
(Fatigue, Beam Stress )                                                                 |
| Strain transformations in two dimension; strain gauges, generalized Hooke’s law |                                      | *Block test 3 (Wk10, 15/5/2015 3-4 pm)                                                |

| Strain energy in a linearly elastic body, Displacements by energy methods | **Block 4** Energy Methods, Yield Criteria, Repetitive Loading | Adaptive Tutorial Exercise 4
Design for components Launch (Wk11)
Due (Wk13) |
| Theories of failure- Criteria under static loading |                                      | Lab assignment submission(Fatigue, Beam Stress ) due (Wk12, 29/5/2015)                  |
| Theories of failure- Criteria under repetitive loading; |                                      | *Block test 4 (Wk13, 5/6/2015 3-4 pm)                                                 |
| Stress concentrations |                                      |                                                                                      |

**Final Exam**

* Venue for the block tests will be notified through Moodle
2. COURSE STAFF

Course convenor

Professor Gangadhara Prusty
Room 464A, Electrical Engineering Building (G17)
Tel: (02) 9385 5939
Email: g.prusty@unsw.edu.au

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

<table>
<thead>
<tr>
<th>Learning outcome</th>
<th>UNSW graduate Attributes¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recognise the fundamentals of Solid Mechanics.</td>
<td>2,3,4</td>
</tr>
<tr>
<td>Demonstrate the fundamentals of stresses and strains</td>
<td></td>
</tr>
<tr>
<td>Identify and express the principles of Solid Mechanics in obtaining the solutions for applications in real life engineering problems.</td>
<td>2,3,4</td>
</tr>
<tr>
<td>Demonstrate and apply the fundamentals of Solid Mechanics in selecting suitable materials in engineering applications.</td>
<td>1,2,3,4,11</td>
</tr>
<tr>
<td>Create and Develop “engineers’ eyes”</td>
<td>2</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Component</th>
<th>Hours per week</th>
</tr>
</thead>
<tbody>
<tr>
<td>In class</td>
<td>6</td>
</tr>
<tr>
<td>Self-study</td>
<td>5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>11</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Component</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures</td>
<td>• Find out what you must learn</td>
</tr>
<tr>
<td></td>
<td>• See methods that are not in the textbook</td>
</tr>
<tr>
<td></td>
<td>• Follow worked examples</td>
</tr>
<tr>
<td></td>
<td>• Hear announcements on course changes</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Type of Assessment</th>
<th>Basic marks and weighting</th>
<th>Reason for assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block tests 1-4</td>
<td>4x7=28</td>
<td>Four tests to assess basic knowledge</td>
</tr>
</tbody>
</table>
| 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

<table>
<thead>
<tr>
<th>Total marks</th>
<th>13:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanics Fundamentals</td>
<td>3</td>
</tr>
<tr>
<td>Torsion</td>
<td>1</td>
</tr>
<tr>
<td>SF &amp; BM</td>
<td>3</td>
</tr>
<tr>
<td>2D &amp; 3D-Mohr’s circle</td>
<td>3</td>
</tr>
<tr>
<td>Deign of Components</td>
<td>3</td>
</tr>
</tbody>
</table>

**Exam (written questions covering the whole course)**

| 40 |

**To further enhance your learning abilities beyond normal contact hours**

**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:
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.

<table>
<thead>
<tr>
<th>Type of Assessment</th>
<th>Block tests 1-4</th>
<th>Adaptive Tutorial exercise</th>
<th>Laboratory</th>
<th>Final Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Repeat test only for illness and other emergencies</td>
<td>Online submission</td>
<td>Reports submission via school assignment boxes</td>
<td>Standard UNSW arrangements</td>
</tr>
</tbody>
</table>

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:
  


School study guide

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

G Prusty      Feb 2015