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Prepared by G Prusty/ D Lyons, June 2015
1. YOUR COURSE AT A GLANCE
COMPOSITES 3M:
MATERIALS, MECHANICS AND MANUFACTURING

(a) Composite material constituents and their properties.

(b) Manufacturing methods and processes.

(c) Micromechanical analysis of composite strength and stiffness:
   - Assumptions and limitations.
   - Longitudinal strength and stiffness.
   - In-plane shear modulus and poisson’s ratio.

(d) Elastic properties of the unidirectional lamina:
   - Engineering constants.
   - Stress-strain relationship of a thin lamina.
   - Transformation of stress and strain and elastic constants.
   - Typical elastic properties of a unidirectional lamina.

(e) Analysis of laminated composites
   - Basic assumptions.
   - Strain-displacement relationship.
   - Laminate stiffness.
   - Determination of lamina stress and strain.
   - Types of laminate configuration.

(f) Failure theories and strength of unidirectional lamina:
   - Micro-mechanics of failure of unidirectional lamina.
   - Failure theories.
   - Importance of shear stress.
   - Choice of failure criteria.
   - Typical strength properties.

(g) Design of components:
   - International standards for tests and certification.

(h) Finite element modelling and analysis of composite panels.

(i) Structural health monitoring and non-destructive testing methods.

* Topics during the weekly teaching format might be varied or changed
2. COURSE STAFF

Course convenors

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3. COURSE INFORMATION

Details

This is a HYBRID course offered to final year undergraduate and postgraduate students, worth 6 Units of Credit

Nominal student time: 10 hours per week, including 3 or 4 hours per week class contact time.

Course Objectives

On successful completion of this course, students should be able to: (a) Understand the use of fibre-reinforced composites in structural applications and (b) Develop a basic understanding of the use of composite materials, micromechanics of layered composites, analysis and design of composite structures and failure analysis of laminated panels.

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

Composite Materials and Mechanics takes the themes of the fundamentals of material science and engineering and applies them in an engineering context.

The objective of this course is to develop a solid understanding of the properties of composite materials, micromechanics and lamination theory, together with the analysis and manufacture of lightweight composite structures in a unified and integrated manner for an undergraduate/graduate student. These are fundamental to mechanical, civil and material science engineering and related programs such as mechatronic engineering, naval architecture, aerospace engineering and biomedical engineering as well as manufacturing and industrial design.
Expected student learning outcomes

<table>
<thead>
<tr>
<th>Learning outcome</th>
<th>UNSW graduate attributes¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recognize the fundamentals of orthotropic materials and mechanics of materials.</td>
<td>2,3,4</td>
</tr>
<tr>
<td>Demonstrate the fundamentals of directional stresses and strains.</td>
<td>2,3,4</td>
</tr>
<tr>
<td>Develops a solid understanding in the properties of composite materials.</td>
<td>2,3,4</td>
</tr>
<tr>
<td>Develops an understanding of micromechanics and lamination theory together with</td>
<td>1,2,3,4,11</td>
</tr>
<tr>
<td>the analysis and manufacture of lightweight composite structures in a unified and</td>
<td></td>
</tr>
<tr>
<td>integrated manner.</td>
<td></td>
</tr>
<tr>
<td>You will learn how to design a composite structure and be able to test and</td>
<td>2, 3,4</td>
</tr>
<tr>
<td>confirm its mechanical properties.</td>
<td></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 this course is based on lectures and planned laboratory activities.

UNSW expects 25-30 hours of student time per Unit of Credit spread across all the learning opportunities listed above. For MECH 9420 (6UoC) this means approximately:

In class 4 hours per week
Self-study 6 hours per week
TOTAL 10 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

<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>
<tr>
<td>Laboratory/Problem solving class</td>
<td>• Be guided by course notes and demonstrators.</td>
</tr>
<tr>
<td></td>
<td>• Ask questions.</td>
</tr>
<tr>
<td></td>
<td>• Do problems, as set out in the course notes.</td>
</tr>
<tr>
<td></td>
<td>• Work with colleagues.</td>
</tr>
</tbody>
</table>

¹ [https://eng-portal.unsw.edu.au/intranet/mech-student/Students/Mechstudents/SitePages/Graduate%20Attributes.aspx](https://eng-portal.unsw.edu.au/intranet/mech-student/Students/Mechstudents/SitePages/Graduate%20Attributes.aspx)
| Private study (including Moodle) | Review lecture material and textbook.  
|                               | Do set problems and assignments.  
|                               | Discuss with fellow students.  
|                               | Join Moodle discussions of problems.  
|                               | Download materials from Moodle.  
|                               | Keep up with notices and find out marks via Moodle.  
| Assessments (assignments, 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 micro-mechanics of composites.
- become proficient in developing your understanding for engineering applications.
- become proficient in calculation layout and development.
- developed correct, professional technique.
- become proficient in using composite materials fundamentals to solve practical problems and apply.
- come to see the world through “engineers’ eyes”
- prepared yourself for your future career.

Scheme
The final grade in MECH9420 will be based on the sum of the scores from each of the assessment components.
- Final grades may be adjusted by scaling with the approval of the appropriate departmental meeting.
- **A pass in this course requires a mark of 50% in assessments and final examination.**

Basic knowledge is assessed after each one of the assignments. Marks are awarded as shown:

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Percentage</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment 1</td>
<td>15%</td>
<td>Week 5 (Monday, 24th August)</td>
</tr>
<tr>
<td>Assignment 2</td>
<td>20%</td>
<td>Week 9 (Friday, 18th September)</td>
</tr>
<tr>
<td>Assignment 3</td>
<td>20%</td>
<td>Week 13 (Friday, 30th October)</td>
</tr>
<tr>
<td>Examination</td>
<td>45%</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td></td>
</tr>
</tbody>
</table>

A standard specification is available from the School office to aid presentation of your assignments (in all courses). All submissions should have a standard School cover sheet: [https://eng-portal.unsw.edu.au/intranet/mech-student/Document-Centre/Documents/MME%20Individual%20Assignment%20Cover%20Sheet.pdf](https://eng-portal.unsw.edu.au/intranet/mech-student/Document-Centre/Documents/MME%20Individual%20Assignment%20Cover%20Sheet.pdf) (also available on this subject’s Moodle page). All submissions are expected to be neat and clearly set out. All calculations should be shown. In the event of incorrect answers, marks are awarded for method and understanding.
Late submissions attract a penalty of ten percent per day, unless prior dispensation has been given. You must consult the lecturer before the due date to avoid penalty. It is always worth submitting as, in the event of difficulty making the final grade, any late penalties may be removed.

Assessment Criteria

Assignment/ 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 the report in accordance with the MECHENG guidelines.
- Attendance and participation during the laboratory experiments.

Final examination:

- Use the basic concepts of micro- and macro-mechanics of structures.
- Systematic approach to outline the steps for a problem and use the necessary fundamental concepts covered in the lectures and problem solving classes.
- Correctness of the solution with the aid of necessary diagrams/sketches and the use of appropriate units.

Presentation requirements

All submissions should have a standard School cover sheet which is available at https://eng-portal.unsw.edu.au/intranet/mech-student/Document-Centre/Documents/MME%20Individual%20Assignment%20Cover%20Sheet.pdf 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:

\[
A_{bow} = 0.0035 Amf/V \\
= 0.0035 \times 480 \times 0.95 \times 1.0 \times 18.00 \\
= 28.7 \text{ m}^2
\]

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>Reports submission via school assignment boxes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Examination</td>
<td>Standard UNSW arrangements.</td>
</tr>
</tbody>
</table>

Late submissions will receive a 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 convener before the due date. Special consideration for assessment tasks of 20% or greater must be processed through [https://student.unsw.edu.au/special-consideration](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](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 plagiarize. 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](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](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

**Detailed listing**

See page 10 for a week-by-week listing of class activities.
8. RESOURCES FOR STUDENTS

REFERENCE TEXTS:


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.
<table>
<thead>
<tr>
<th>Wk</th>
<th>Lecture (2 hr) – Wed 13:00-15:00</th>
<th>Problem Solving Class/Laboratory (2 hr) – Fri 09:00-11:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to Composite Materials</td>
<td>Lab tour</td>
</tr>
<tr>
<td></td>
<td>-Lab tour</td>
<td>WHS/RM forms organized</td>
</tr>
<tr>
<td>2</td>
<td>Processing of fibre reinforced composites (DL)</td>
<td>-Explaination of materials and demonstration of equipment. Assignment 1 issued-a review document on composite materials-applications, relevant to your degree program. Submission due in Wk 5, to be peer reviewed! (15%)</td>
</tr>
<tr>
<td>3</td>
<td>Processing of fibre reinforced composites (DL)</td>
<td>Sample problem solving class</td>
</tr>
<tr>
<td>4</td>
<td>Composite Strength and Stiffness</td>
<td>- Sample problem solving class</td>
</tr>
<tr>
<td>5</td>
<td>Micro-mechanical Analysis, Elastic properties of uni-directional lamina</td>
<td>- Sample problem solving class</td>
</tr>
<tr>
<td>6</td>
<td>Laminated Composites</td>
<td>Sample problem solving class</td>
</tr>
<tr>
<td>7</td>
<td>Analysis of laminated composites and composite beams</td>
<td>Sample problem solving class Assignment 2 issued- report on the materials, manufacturing method, experimental interpretation and validation using finite element software. Submission due in Wk 9 (20%)</td>
</tr>
<tr>
<td>8</td>
<td>Failure Theories</td>
<td>Large sample manufacture- Make, bake and break /discussion (Wk 8-12) Assignment 3 issued- report on the large test article manufactured and tested. Submission due in Wk 13 (20%)</td>
</tr>
<tr>
<td>9</td>
<td>(a)Strength of UD lamina (b)First-ply and Ultimate failure</td>
<td>Large sample manufacture and test</td>
</tr>
<tr>
<td>10</td>
<td>Design of laminates (DL)</td>
<td>Large sample manufacture and test</td>
</tr>
<tr>
<td>11</td>
<td>Structural Health Monitoring and NDT methods</td>
<td>Large sample manufacture and test</td>
</tr>
<tr>
<td>12</td>
<td>Standards, and Codes</td>
<td>Large sample manufacture and test</td>
</tr>
</tbody>
</table>

G Prusty/D Lyons June 2015