UNSW AUSTRALIA

Course Outline

Semester 2 2015

Never Stand Still | Engineering | Mechanical and Manufacturing Engineering

MECH9420

COMPOSITE MATERIALS AND MECHANICS

Contents

1. Staff Contact Details

Contact details and consultation times for course convenors

Professor Gangadhara Prusty
Ainsworth Building (J17), Room 208F
Tel: (02) 9385 5939
Email: g.prusty@unsw.edu.au

Mr David Lyons CEng
Ainsworth Building (J17), Room 208D
Tel: (02) 9385 6120
Email: david.lyons@unsw.edu.au

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

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

2. Course details

Credit Points:

This is a hybrid (final year undergraduate/postgraduate) 6 unit-of-credit (UoC) course, and involves 4 hours per week (h/w) of face-to-face contact.

The UNSW website states “The normal workload expectations of a student are approximately 25 hours per semester for each UoC, including class contact hours, other learning activities, preparation and time spent on all assessable work. Thus, for a full-time enrolled student, the normal workload, averaged across the 16 weeks of teaching, study and examination periods, is about 37.5 hours per week.”

This means that you should aim to spend about 9 h/w on this course. The additional time should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

Contact Hours

	Day	Time	Location
Lectures	Wednesday	1pm - 3pm	J17 Ainsworth G02 (weeks 1 – 12)
Demonstrations	Friday	9am – 11am	G17 EE 219, or
		(Weeks 4-7)	H20 CE G6, or
			E12 UNSW BusSchool 105, or
			H20 CE 102.
		(Weeks 2,3,8,9-12)	J18 L102/L103

Summary of the Course*

(a) Composite material constituents and their properties.
(b) Manufacturing methods and processes. Practical demonstration sessions in the lab (Friday).
(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

Aims of the Course

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.

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**
1.	Recognize the fundamentals of orthotropic materials and mechanics of materials	PE1.1, 1.2
2.	Demonstrate the fundamentals of directional stresses and strains.	PE1.3
3.	Develops a solid understanding in the properties of composite materials.	PE1.3
4.	Develops an understanding of micromechanics and lamination theory together with the analysis and manufacture of lightweight composite structures in a unified and integrated manner	PE1.3
5	You will learn how to design a composite structure and be able to test and confirm its mechanical properties	PE2.1, 2.2, 2.3

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

4. Course schedule

"Composites 3M": Materials, Mechanics and Manufacturing		
Wk	Lecture (2 hr) – Wed 13:00-15:00	Problem Solving Class/Laboratory (2 hr) – Fri 09:00-11:00
1	Introduction to Composite Materials	
2	Processing of fibre reinforced composites (DL)	-Lab tour -WHS/RM forms organized
3	Processing of fibre reinforced composites (DL)	-Explanation 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%)*
4	Composite Strength and Stiffness	- Sample problem solving class
5	Micro-mechanical Analysis, Elastic properties of uni-directional lamina	- Sample problem solving class
6	Laminated Composites	- Sample problem solving class
7	Analysis of laminated composites and composite beams	- 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%)*
8	Failure Theories	- 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%)*
9	(a)Strength of UD lamina (b)First-ply and Ultimate failure	- Large sample manufacture and test
10	Design of laminates (DL)	- Large sample manufacture and test
11	Structural Health Monitoring and NDT methods	- Large sample manufacture and test
12	Standards, and Codes	- Large sample manufacture and test

5. Assessment

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:

Assessment	Weight	Due date, time and submission (via Turnitin / School assignment boxes)	Learning outcomes assessed
Assignment 1	15%	due Week 5 (5pm Monday 24 August)	1,2,3
Assignment 2	20%	due Week 9 (5pm Monday 21 September)	4,5
Assignment 3	20%	due Week 13 (5pm Monday 26 October)	4,5
Examination	45%	TBC	1-5
TOTAL	**100%**		

Assignments

Presentation

All submissions must have a completed standard School cover sheet available on this subject’s Moodle site.

All submissions are expected to be neat, and clearly set out. Your results are the pinnacle of all your hard work. Presenting them clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect.

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)

Submission

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.

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	
Assignments	Reports submission via school assignment boxes.
Final Examination	Standard UNSW arrangements.

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.

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.

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 Administrative Matters.

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 https://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 Administrative Matters, available on the School website and on Moodle, and the information on UNSW's Special Consideration page.

6. Expected Resources for students

Reference texts

- R. A. Shenoi and J. F. Wellicome, Composite Materials in Maritime Structures, Vol 1&2, Cambridge University Press, U.K., 1993.
- Isaac M. Daniel and Ori Ishai, Engineering Mechanics of Composite Materials, Oxford University Press, 1994.
- Mel M. Schwartz, Composite Materials, Vol 2, Prentice Hall, New Jersey, 1997.

Moodle site for MECH9420. 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.

This course is being offered for the first time in 2015.

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 presented in a School handout, Administrative Matters, available on the School website.

9. Administrative Matters

You are expected to have read and be familiar with *Administrative Matters*, available on the School website: www.engineering.unsw.edu.au/mechanical-engineering/sites/mech/files/u41/S2-2015-Administrative-Matters_20150721.pdf

This document contains important information on student responsibilities and support, including special consideration, assessment, health and safety, and student equity and diversity.

Gangadhara Prusty
David Lyons
20 July 2015

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