UNSW SYDNEY | Australia's Global University

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

Term 1, 2020

ENGG2400 MECHANICS OF SOLIDS

COURSE DETAILS

Units of Credit 6

Contact hours 6 hours per week

Class	Tuesday	4pm - 6pm	**Mathews Th A & C**
	Thursday	12pm – 2pm	**Mathews Th A & C**
Mid-Term Quiz	***Thursday 2nd April Wk 7***	*6pm – 8pm*	***Burrows Th***

Final Examinations *2nd May to 15th May*

Workshop ***Friday 9am–11am, 11am-1pm, 1pm-3pm, 3pm-5pm;***

Room	Demonstrators	Time
Col LG02	**Yatong Nie Vivien Kha**	Friday 9am – 11am
MorvB G4	**Loizos Loizou Julia Potgieter**	Friday 9am – 11am
JGoods LG21	**James Hong Nathan Wong**	Friday 9am – 11am
Col LG02	**Yatong Nie Vivien Kha**	Friday 11am – 1pm
MorvB G4	**Loizos Loizou Julia Potgieter**	Friday 11am – 1pm
JGoods LG21	**James Hong Nathan Wong**	Friday 11am – 1pm
Ainsworth 101	**Ryan Chanaka Siriwardane Patricia Kesuma**	Friday 1pm – 3pm
MorvB G3	**Ahmad Jafari Javier Videla**	Friday 1pm – 3pm
Ainsworth G01	**Thiha Htoo Zaw Sheila Sun**	Friday 1pm – 3pm
Ainsworth 101	**Ryan Chanaka Siriwardane Patricia Kesuma**	Friday 3pm – 5pm
MorvB G3	**Ahmad Jafari Javier Videla**	Friday 3pm – 5pm
Ainsworth G01	**Thiha Htoo Zaw Sheila Sun**	Friday 3pm – 5pm

Lecturers **Associate Professor Mario M. Attard** **Weeks 1 to 5**

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Postgraduate Teaching Assistant **Junqi Zhang**

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FORMATION ABOUT THE COURSE

The aim of this course is to introduce you to the fundamental concepts and principles applied by engineers - whether Civil, Environmental, Mechanical, Aeronautical - in the design of structures of all sorts of sizes and purpose. We will build upon the mathematics, physics and statics courses of the first year, extending Newtonian Mechanics to address and understand the elastic and to certain extent inelastic behaviour of trusses, beams and frames.

The course is taught at least twice a year and includes students from Civil Engineering, Civil with Architecture, Mechanical Engineering, Mining Engineering and Surveying Engineering.

HANDBOOK DESCRIPTION

This course provides an introduction to the fundamentals to the mechanics of solids. The topics include properties of plane cross-sectional shapes including centroid & principal second moment of area; concepts of stress and strain; 2D transformation of stresses and strains under axis rotation; principal stresses and strains; Mohr's circle of stress and strain; stress-strain relationships; elasticity, thermal strain, Poisson's ratio and Hooke's Law; bars under axial force; Indeterminate axial force systems; elastic bending stress formula; composite beams; deflections due to bending; step functions; simple indeterminate beams; shear flow; shear centre; torsion of circular shafts and box sections; failure criterion; slender column buckling.

See link to virtual handbook:

https://www.handbook.unsw.edu.au/undergraduate/courses/2020/engg2400/

OBJECTIVES

The objectives of this course are to:

- reinforce your knowledge of statics and to expand this knowledge in the areas of linear strain and stress analysis, thus enabling you to deal with more complex and integrated engineering problems involving Mechanics of Solids;
- to introduce you to the basic principles and laws underlying Mechanics of Solids;
- to familiarise you with the modelling and analysing techniques when formulating and solving problems for predicting the states of stress and strain for bodies in static equilibrium;
- to give you an opportunity to develop and reflect on graduate attributes such as critical thinking and problem solving, lifelong learning skills and collaborative skills.

TEACHING STRATEGIES

The teaching strategies that will be used include:

- **Lectures** that will focus on the development and application of generalised problem-solving processes for the stress, strain and deformation analysis of structures. Lectures will also emphasise the relationship of the content to engineering practice and will provide an opportunity for reflection on learning. The lectures are recorded and should be available on the Moodle course page.
- **Problem** classes will concentrate on strategies for solving such problems. You will be encouraged, from time to time, to work in small groups to solve problems.
- **Moodle Learning Course Page** provides a step by step guide on the course. There is a discussion forum to help provide interaction and help from your peers. Links to video recordings and learning modules to help you learn the solution techniques for many of the subject areas.
- **Recorded lectures** will be uploaded to help students to revise. Please note that the recorded lectures are **NOT** substitutes for attending lectures or reading the lecture notes. The quality of the recorded lectures can be poor and are not professional produced. The pace of the recorded lectures can seem very slow because the lecturer is expecting students to take notes in the class and is adjusting their pace accordingly.

Suggested approaches to learning in this course include:

- Regular participation in lectures and class problem sessions. *Review lecture and class problem material. Follow worked examples. Reflect on class problems and quizzes.*
- Complete all the required tasks in the Moodle course page for this course.
- Weekly reading and recording of your learning.
- Appropriate preparation for class problem activities.
- Planning your time to achieve all assessment requirements (see assessment).
- We encourage you to work with your peers. A good way to learn the material is in small study groups. Such groups work best if members have attempted the problems individually before meeting as a group. A valued and honest collaboration occurs when, for example, you "get stuck" early on in attacking an exercise and go to your classmate with a relevant question. Your classmate then has the opportunity to learn from your question as well as help you. You then bring something to the collaboration. You can learn too from last year's problem sets and quizzes if used as a check or corrective when you seem to have hit a dead end.
- Students who perform poorly in the quizzes are strongly encouraged to discuss their progress with the lecturers during the term. Please do not suffer in silence – seek the help at an early stage! We would like you to make most of this learning process and receive a high grade in the course.

EXPECTED LEARNING OUTCOMES

After completing this course, the learning outcomes are:

L1. Demonstrate an understanding of basic concepts and the role of Mechanics of Solids in the analysis and design of structures.
L2. Gain knowledge about the theoretical background that has led to the concept of stresses and strains.
L3. Understand and apply the concepts of stresses and strains to formulate and evaluate determinate and indeterminate axial force and bending moment problems; be able to evaluate stresses due to axial force, bending moment, shear and torsion in symmetrical and unsymmetrical cross-sections.
L4. Calculate and evaluate beam deflections for statically determinate and indeterminate beams by using integration methods and step functions; be able to calculate shear and torsion stresses due to shear and torsion forces respectively.
L5. Calculate principal stresses, strains and combined stresses and draw Mohr's circle.

These learning outcomes map to Engineers Australia Stage 1 Competencies PE1.1 & PE1.2

1.1. Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline.

1.2. Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline.

Self-centred and self-directed learning (expectations of the students):

In addition to the class problem sessions, you are expected to commit **6 - 8 hours per week** (1.5 hours for each hour of contact) to independent learning and general problem solving.

ASSESSMENT

Assessment will be based on **on-line quizzes**, **completion of online Moodle modules, a mid-trimester quiz** and **a final exam**. These components will address problems consistent with those you are likely to face as a professional Civil/Environmental Engineer.

- The purpose of **class problem sessions** and on-line **Quiz** will be to provide you with a clear study framework. It will also provide you with the opportunity to develop self-learning and problem-solving skills. Class problem sessions will serve as a basis for discussion with your demonstrator and lecturer. The on-line quizzes, mid-term quiz and final examination are all open book.
- The **online Moodle modules** are learning modules to help you learn the solution strategies for the major topics. The assessment is based on completion of the modules.
- The mid-term quiz and the final exam are given because the course learning outcomes include a significant level of technical learning that can be effectively assessed in an exam environment and because exams have high reliability. It is primarily designed to align with UNSW graduate attributes 2 and 3.
- *A mark **of at least 40%** in **the final examination** is required before the class work (hand-in quizzes, online tasks and mid-semester quiz) is included in the final mark.* The formal exam scripts will not be returned but you are permitted to view the marked script.

The relative value of each of the assessable tasks is as follows:

Item & Length	Weighting	Due Date	Marks Returned	Assessment Criteria & Learning Outcomes Assessed
Online Moodle Quizzes **(90 minutes)**	20%	***Wednesday 8pm 26th Feb.*** ***Wednesday 8pm 11th March*** ***Wednesday 8pm 8th April*** ***Wednesday 8pm 22nd April***	Quiz 1 – 4th March Quiz 2 – 18th March Quiz 3 – 15th April Quiz 4 – 29th April	These are Open book online quizzes which are done either at home, library or on campus. The online quizzes are open on a Wednesday evening at 8pm on the date specified. The online quizzes run for 90 minutes. Marks are awarded for the correct answers. The topics covered in each online quiz are listed on the Moodle course page. **L1** to **L5**.
Online Moodle Learning Modules	5%	Before the end of Week 10 (12am April 26th)	30th April	Full marks are awarded for completing all the online learning modules. **L1** to **L5**.
Mid-Term Quiz **(1 hour)**	**15%**	**Week 7 Thursday 6-8pm Burrows Th 2nd April**	16th April	This is a 1 hr quiz which covers the work in Weeks 1 to 5. It is Open book. Marks are awarded for correct answers and there are some marks for getting the method correct. **L1** to **L5**.
Final Examination **(2 hours)**	**60%***	Final Examination Period		The final exam is a 2hr Open Book examination. The exam covers all the worked covered during the term. Marks are awarded for correct answers and there are marks for getting the method correct. **L1** to **L5**.

*Note: **A mark of at least 40% in the final examination is required before the class work is included.**

The examinations and online problems show evidence of application of theoretical concepts to solving problems. There are no exemptions from any part of this assessment. If you are repeating the course, you must complete all components this year. Students who perform poorly in the quizzes are recommended to discuss progress with the lecturer during the term.

Note: The course coordinator reserves the right to adjust the final scores by scaling if agreed to by the Head of School.

IMPORTANT: ***Supplementary Examinations for Term 1 2020*** *will be held on Monday 25th – Friday 29th May (inclusive) should you be required to sit one. You are required to be available during these dates. Please do not to make any personal or travel arrangements during this period.*

PENALTIES

Late work will not be accepted beyond the due date without prior permission.

CLASS PROBLEM SESSIONS

The class problem sessions (workshops) are compulsory and begin in the 1st week of term. Each class will have a one, two or sometimes three demonstrators. We encourage you to develop a close working relationship with your demonstrators and the rest of your class. The course lecturers will try to visit each workshop at least once during the term.

COURSE PROGRAM

Week	Topic & Lecture Content & Workshop Content Lectures: 2 x 2hrs	Assessment Workshops:2hrs	Online Learning Moodle Module
1 – 19th Feb	Introduction. **Geometric Properties of Cross-Sections**. Transformation of coordinates, Second Moment of Area, Parallel Axis Theorem, Principal section properties, Mohr's circle.	***Class Workshops Start***	**Cross-section Properties & Transformation;**
2 -24th Feb	**Concept of Stress**. Stresses due to Axial Force; Equilibrium of Stresses; Plane Stress; **Stress** Transformation, Principal Stresses. Mohr's circle of Stress; **Concept of Strain**; Plane Strain;	**Online 1 – Quiz**	**Stress Transformation;** **Strain Transformation;**
3 –2nd March	Strain Transformation; Principal strains. Mohr's circle. Strain Rosette. **Mechanical Properties of Materials**. Elasticity, Elastic Modulus, Thermal Strains, Poisson's Ratio. **Hooke's law**, Plane stress & Plane strain. Deformation and Stresses due to **Axial Force**; Non-Prismatic Members; Tapered Members. **Compatibility** of Deformation. **Indeterminate Axial Force Problems**.		**Hooke's Law;** **Axial Force Deformation;**
4 –9th March	**Elastic Bending**. Bending formula for Stress and Strain. **Composite Sections**. Composite Beam Examples.	**Online 2 – Quiz**	**Elastic Bending;** **Composite Sections;**
5 – 16th March	**Inelastic** Bending Stresses. **Plastic** Bending Stresses; **Beam Deflections**. Step Functions. **Indeterminate Beams.**		**Inelastic Bending;** **Deflections of Determinate Beams;** **Deflections of Indeterminate Beams;**
6-23rd March	***Non-Teaching Week***		
7-30th March	**Shear Stress** in Beams. Shear flow.	**Mid-Term QUIZ Thursday 6-8pm Burrows Th** **2nd April**	**Shear Flow in Beams;**
8-6th April	Built Up Sections. Shear Stress in Thin-Walled Beams. Shear Center. Shear Flow in Box Beams	**Online 3- Quiz**	**Shear Flow in Thin-Walled Beams**
9-13th April	**Torsion** of Solid Circular Sections. Plastic Torsion. Torsion in Box Sections		**Torsion**
10-20th April	Buckling of Slender Columns; Failure Theories;	**Online 4- Quiz**	

RESOURCES

Reference

Hibbeler, R.C., Mechanics of Materials, SI Version 9th Edition. Pearson Education.

Additional Readings

Riley, W., Sturges L. and Morris D. (2007), Mechanics of Materials, 6th Edition, John Wiley & Sons.

Websites with Learning Modules

www.mdsolids.com

https://web.mst.edu/~mecmovie/

Technology Enabled Learning and Teaching Website and login to Moodle

http://telt.unsw.edu.au/
https://moodle.telt.unsw.edu.au/login/index.php

Pearson MasterEngineering

http://www.pearsonmylabandmastering.com/northamerica/masteringengineering/

UNSW Library Database

Access Engineering – platform of e-books, videos and interactive tables and graphs.
Look at the Curriculum Map and select "Strength of Materials"

DATES TO NOTE

Refer to MyUNSW for Important Dates available at:

https://student.unsw.edu.au/dates

PLAGIARISM

Beware! An assignment that includes plagiarised material will receive a 0% Fail, and students who plagiarise may fail the course. Students who plagiarise are also liable to disciplinary action, including exclusion from enrolment.

Plagiarism is the use of another person's work or ideas as if they were your own. When it is necessary or desirable to use other people's material you should adequately acknowledge whose words or ideas they are and where you found them (giving the complete reference details, including page number(s)). The Learning Centre provides further information on what constitutes Plagiarism at:

https://student.unsw.edu.au/plagiarism

COURSE EVALUATION AND DEVELOPMENT

The School of Civil and Environmental Engineering evaluates each course each time it is run through (i) the MyExperience Surveys, and (ii) Focus Group Meetings.

As part of the MyExperience process, your student evaluations on various aspects of the course are graded; the Course Coordinator prepares a summary report for the Head of School. Any problem areas are identified for remedial action, and ideas for making improvements to the course are noted for action the next time that the course is run.

Focus Group Meetings are conducted by the four-Year Managers (academic staff) for any students who wish to attend, in each year of the civil and/or environmental engineering programs. Student comments on each course are collected and disseminated to the Lecturers concerned, noting any points which can help improve the course.

ACADEMIC ADVICE

For information about:

- Notes on assessments and plagiarism,
- School policy on Supplementary exams,
- Special Considerations, student.unsw.edu.au/special-consideration
- Solutions to Problems,
- Year Managers and Grievance Officer of Teaching and Learning Committee, and
- CEVSOC.

Refer to Academic Advice on the School website available at:

https://www.engineering.unsw.edu.au/civil-engineering/student-resources/policies-procedures-and-forms/academic-advice

Appendix A: Engineers Australia (EA) Competencies

Stage 1 Competencies for Professional Engineers

	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