MECH4320

ENGINEERING MECHANICS 3

Contents

1. Staff contact details

Contact details and consultation times for course convenor

Name: Dr. David C. Kellermann
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Email: d.kellermann@unsw.edu.au

Consultation time can be arranged via email. Step 1 is to talk to your peers or post on Moodle, step 2 is to discuss with your demonstrator, step 3 is to email your lecturer with your question, and only after all those steps have been exhausted you should attempt to arrange a meeting.

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

Head demonstrator:
Name: Michael Ling
Email: m.z.ling@unsw.edu.au

Please see the course Moodle.

2. Important links

- Moodle
- UNSW Mechanical and Manufacturing Engineering
- Course Outlines
- Student intranet
- UNSW Mechanical and Manufacturing Engineering Facebook
- UNSW Handbook

3. Course details

Credit Points

This is a 6 unit-of-credit (UoC) course, and involves 3 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.
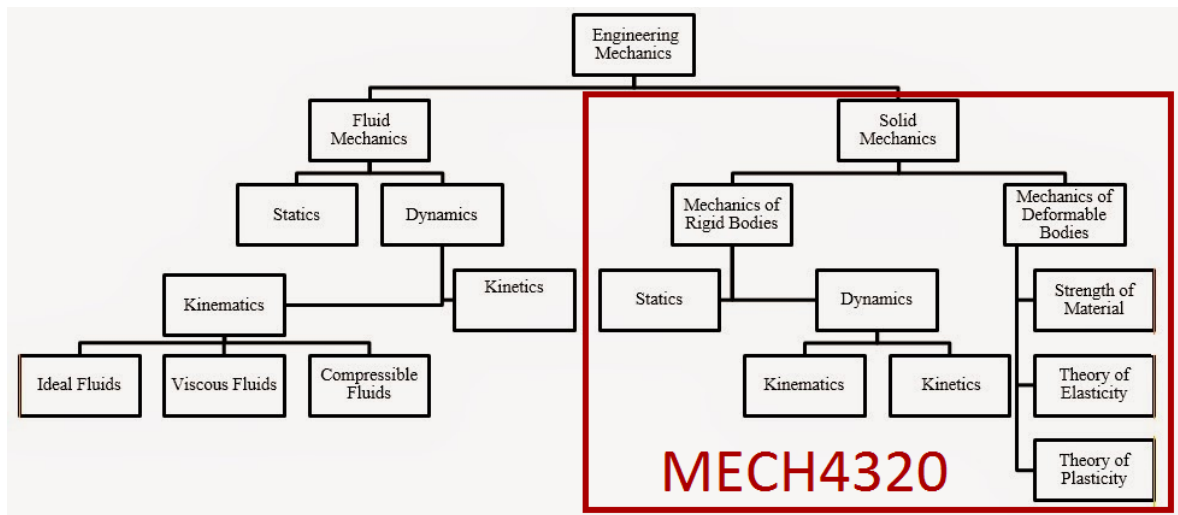
Contact hours

	Day	Time	Location
Lectures	Tuesday	9am – 11am	Old Main Building 230 (K-K15-230)
Problem Solving Sessions (PSS)	Wednesday	3pm – 4pm	Ainsworth Building 101 (K-J17-101)

Summary and Aims of the course

This course is a sequel to courses in Engineering Mechanics (MMAN1300 and MMAN2300) where you will have studied the dynamics of particles, rigid bodies and mechanisms under a number of simplifying assumptions – chiefly that motion occurs in the plane. Although not a prerequisite, it also follows on from the concepts learnt in Solid Mechanics (MMAN2400 and MMAN3400); however we will introduce new absolute tensor notation, which is essentially like starting from scratch. In this course, you will examine systems that move and rotate in all three dimensions. You will also be presented with some instruction in the appropriate background mathematics necessary for the above. We will look at gyroscopic torque through pure three-dimensional formulation. We will introduce students to the modern formulation of continuum mechanics, which is a basis-free formalization of elasticity theory.

In this course we will be looking at advanced topics within the Solid Mechanics (rather than Fluid Mechanics) stream of Engineering Mechanics. The aims of this course are split between the two major disciplines of Solid Mechanics, namely the *Mechanics of Rigid Bodies* and the *Mechanics of Deformable Bodies*:
1. You will gain new ways of seeing, explaining and predicting the behaviour of dynamic engineering systems via the Newton-Euler formulation of rigid body dynamics and a familiarity with the workings of basic Analytical Dynamics.
2. You will gain basic familiarity with some advanced tensor representations of elasticity theory in its more modern form, known as "continuum mechanics", that will allow you to formulate large deformation solutions in solid mechanics.

You will be developing an advanced body of knowledge in engineering mechanics, enhancing your conceptual understanding of the fundamentals of analytical dynamics and nonlinear continuum mechanics - some of the research directions therein as well as your ability to communicate this new understanding to your peers and lay people. This course would be a complement to a Finite Element Methods or Composite Mechanics course.

Student learning outcomes

This course is designed to address the learning outcomes below 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.	Explain and describe principles and components of Rigid Body Dynamics, the Mechanics of Deformable Bodies and their inter-relationships formally and informally, in writing and verbally, to technical experts, peers and lay people.	1.1, 1.3 3.2, 3.4
2.	Model, approximate, analyse and simulate the kinematics of rigid bodies in three dimensions using appropriate computational tools as necessary. Model materials using modern continuum mechanics formulations	1.1, 1.2, 1.3 2.1, 2.2 3.2, 3.4
3.	Model, approximate, analyse and simulate the mechanics of rigid and deformable bodies in three dimensions using Newton-Euler and basis-free formulations and appropriate computational tools as necessary.	1.1, 1.2, 1.3 2.1, 2.2 3.2, 3.4
4.	Apply the principles of engineering mechanics to the dynamics of particles and rigid bodies in three dimensions. Apply the principles of equilibrium, minimum potential energy and objectivity to the mechanics of deformable bodies.	1.1, 1.2, 1.3 2.1

5.	Discern the relevant principles that must be applied to describe or measure the equilibrium or motion of dynamic systems or the relevant measures in finite deformation for both stress and strain; Discriminate between relevant and irrelevant information in the context.	1.1, 1.2, 1.3 2.1

4. Teaching strategies

This course will be delivered both in the classroom and online. Full participation in the class means that you will participate fully in both arenas. That is, you will be held accountable for all content, instructions, information, etc. that is delivered either in class or online. There will also be homework exercises that you will have to complete during your self-study time.

Online: The online forum for participation in this class is the Moodle Platform, specifically the MECH4320 course at http://moodle.telt.unsw.edu.au/. All official online interactions will take place or be linked clearly and appropriately from this site.

In class: There are two in-class activities in a typical week which we refer to as the Lecture and Problem Solving Class based on the timetable above.

Both the online and in-class segments of this course are organised on the following principles:

1. **Learning:** Student learning is the first priority - teaching and assessment are secondary concerns. Learning here is defined as gaining new ways of seeing the world, not as being filled with information. We are trying to transform you into engineers and critical thinkers in the discipline.

2. **Peer Interaction:** Learning is a social activity, and research shows that you will learn most and best when you are actively taught by your peers and, in turn, when you teach them.

3. **Authenticity:** We will have as much authenticity of engineering practice as is possible within the constraints of the course and where it does not restrain your learning.

4. **High standards:** We will have high standards for achievement in the course, and everyone (including staff) will be accountable for putting in the effort to get you to the standard.

5. **Openness:** As much of the course as possible will be conducted in the open where all participants can be aware of it and comment upon it.

6. **Process:** The focus of the course will be on processes, not outcomes. The right outcomes will be a by-product of following the correct processes.

5. Course schedule

	Week		Topics	Readings
Block 1	1		Linear Transformations, Rotation Matrices Kinematics and Kinetics of Particles in three dimensions Cylindrical Polar Coordinate System	AED: Ch. 1.1-4, Ch. 2.1-3, Ch. 3.1-2
	2		Spherical Coordinate System Path Coordinates Covariant and Contravariant Basis Vectors	AED: Ch. 2.1-3, Ch. 3.1-2, Ch. 6.1
	3		Work, Energy and Power for a Particle Conservative Forces Constraints	AED: Ch. 3.1-2, Ch. 4.1, Ch. 6.2
Block 2	4	**Mechanics of Rigid Bodies**	Kinematics of rigid bodies in three dimensions Introduction to Tensors Rotation and Angular Velocity Tensors	AED: Ch. 4
	5		Moment-free motion of rigid bodies Centre of Mass Inertia Tensors and Principle Axes	AED: Ch. 5.1-3
	6		Newton-Euler formulation of rigid bodies Euler Angles Work, Energy and Power for a Rigid Body	AED: Ch. 4.2, Ch. 5.4-6
Block 3	7		Introduction to vector and tensor algebra and calculus: - Indicial notation - Absolute tensor notation	NSM: Ch. 1
	8		Kinematics: - Deformation tensor and polar decomposition - Finite strain tensors	NSM: Ch. 2
	9	**Mechanics of Deformable Bodies**	Forces, tractions Finite stress tensors and transformations Lagrangian and Eulerian measures	NSM: Ch. 3
Block 4	10		Constitutive modelling Material tensors Orthotropic material modelling	NSM: Ch. 6
	11		Material nonlinearity and hyperelasticity Strain energy functions Compressible and incompressible materials	NSM: Ch. 6
	12		Principle of minimum potential energy Balance laws Objectivity: Principle of Material Frame indifference	NSM: Ch. 4, Ch. 5

The table above refers to the following recommended texts:

AED: Advanced Engineering Dynamics

NSM: Nonlinear Solid Mechanics

6. Assessment

Assessment overview

Assessment	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
Weekly Hand-in of problem sets	3-6 Questions	1% each, max 12%	1 and 4	A sound attempt at all questions.	Hand in during the following problem solving class, students who come late or leave early will be given 0.5 maximum.	One week late, maximum 0.5 marks	Immediate
4 Block Tests	30-45 mins	9% each, max 36%	1 - 5	Lecture material up to weeks 3, 6, 9 and 12.	During week 4, 7, 10 and 13	No supplementary	Two weeks later
Block mark for class and online participation	3 weeks each	1% each, max 4%	1	Online and class participation	Participation in Moodle forum, in lectures and PSS. Some task to be given in class/Moodle	End of each block	End of each block
Final exam	3 hours	48%	1 - 5	All course content from weeks 1-12 inclusive.	Exam period, date TBC	N/A	Upon release of final results

Examinations

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](#). Special considerations must be lodged within 48 hours of the assessment; otherwise they will be automatically rejected.
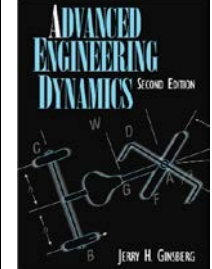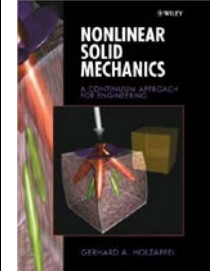
7. Attendance

By UNSW Policy, you are required to attend a minimum of 80% of all classes, including lectures, labs and seminars. It is possible to fail the course if your total absences equal to more than 20% of the required attendance. Please see the [School intranet](#) and the [UNSW attendance page](#) for more information.

We will be enforcing an attendance minimum of 8 of 12 lectures (67%) for the semester by way of role taking.

8. Expected resources for students

The following textbooks will be used for this course. I have chosen economic textbooks that are also high quality reference books you will be able to use throughout your career. I expect all students to bring the relevant book to class during the coverage of each topic.

	Advanced Engineering Dynamics, (AED) *2nd Edition (1998)* *by Ginsberg, Jerry H.* *Cambridge University Press*	**Topic:** Mechanics of rigid bodies **Covered:** Weeks 1-6	Available from UNSW Bookshop $97.65
	Nonlinear Solid Mechanics: (NSM) **A Continuum Approach for Engineering** *1st Edition (2000)* *by Holzapfel, Gerhard A.* *John Wiley and Sons, Ltd*	**Topic:** Mechanics of deformable bodies **Covered:** Weeks 7-12	Available from UNSW Bookshop $106.95

Weekly course material will be available on the MECH4320 Moodle Page:
http://moodle.telt.unsw.edu.au/.

These and many other relevant resources are available at the UNSW Library:
https://www.library.unsw.edu.au/

9. Course evaluation and development

Feedback on the course is gathered periodically using various means, including the UNSW myExperience 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.

In this course, recent improvements resulting from student feedback include:
- More reasonable workload, in line with typical 6UOC subject
- Better textbooks
- Improved structure
- Improved lecture notes
- More past papers
- More learning resources and more practice questions
- More practical questions relating to engineering applications

10.   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: 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: 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.

11. Administrative matters and links

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

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