Course Outline

Semester 2 2015

Never Stand Still | Engineering | Mechanical and Manufacturing Engineering

MECH4320

ENGINEERING MECHANICS 3

Contents

1. Staff Contact Details

Contact details and consultation times for course convenor

Nathan Kinkaid
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Consultation about course matters will be available in person in Room 414 on Thursdays from 1300 – 1500. Consultation is available at other times by appointment. Other queries and questions can be directed by email or to a relevant Moodle forum.

2. 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.

There is no parallel teaching in this course.

Contact Hours

Lectures	**Day**	**Time**	**Location**
Weeks 1-12	Monday	3pm – 5pm	Vallentine Annexe (H22) 121
Demonstrations	Tuesday	4pm – 5pm	Ainsworth (J17) 201
Weeks 2-13	Tuesday	5pm – 6pm	Ainsworth (J17) 201

You will be expected to attend one of the above Demonstrations.

Summary 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. In this course, you will examine systems that move and rotate in all three dimensions. You will be approaching these systems from both the Newton/Euler formulation and analytical mechanics (Lagrangian or Hamiltonian) points of view, and we will attempt to draw a strong connection between these different approaches. You will also be presented with some instruction in the appropriate background mathematics necessary for the above.

Aims of the Course

The aims of this course are twofold:

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 and powerful dynamical techniques such as Lagrange's equations for rigid bodies and Hamilton's Equations.

Achieving these aims will allow you to solve a very general class of problems in dynamics that ranges from Orbital Mechanics to gyroscopes to machine and linkage design. Furthermore, you will be prepared to take on unsolved, research-level problems in Dynamics. You will be developing a body of specialist knowledge in engineering, enhancing your conceptual understanding of the fundamentals of dynamics and some of the research directions therein as well as your ability to communicate this new understanding to your peers and lay people.

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.	Explain and describe principles and components of Rigid Body Dynamics 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.	1.1, 1.2, 1.3 2.1, 2.2 3.2, 3.4
3.	Model, approximate, analyse and simulate the dynamics of rigid bodies in three dimensions using Newton-Euler 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 analytical mechanics to the dynamics of particles and rigid bodies in three dimensions.	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 and discriminate between relevant and irrelevant information in the context.	1.1, 1.2, 1.3 2.1

3. 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.

4. Course schedule

The following is an indication only. Topics may change due to unforeseen circumstances with little notice.

Week	Topics	Suggested Readings
1	Kinematics and kinetics of particles in three dimensions Coordinate sytems Motion with reference to moving frames	IDE: C1.1-4, C2.2 AED: C1.1-4, C2.1-3, C3.6-7 AD: C1.1 PoD: C2, C3.1 EDaP: C1, C2, C3
2	Work, energy and momentum for particles Conservative forces Co-variant and contra-variant basis vectors Constraints	IDE: C1.7-8, C2 AED: C1.5, C3.1-2, C6.2 AD: C1.3-4 PoD: 3.2-4 EDaP: C5
3	Introduction to kinematics of rigid bodies in three dimensions Centre of mass Angular momentum and the inertia tensor	IDE: C6.1-5, C7, Appendix AED: C3.1-2, C4.1, C5.2 AD: C3.1-3 PoD: C7.1-3,5 EDaP: C8.7-8
4	Kinematics of rigid bodies in three dimensions Principal axes Euler Angles Newton-Euler formulation of rigid body dynamics	IDE: C6.6-10, C9.1-2,4 AED: C4.2, C5.1-4 AD: C3.3 PoD: 7.6-13, C8.1-2 EDaP: C9.1
5	Moment-free motion of rigid bodies Work, energy and power for a rigid body	IDE: C8.7, C9.3-6 AED: C5.6, C8.1 PoD: C7.4, C8.3 EDaP: C9.2
6	Poinsot's Construction Applications in rigid body dynamics: Satellite attitude dynamics Static and dynamic balancing of rotors Gyroscopes and Spinning tops	IDE: C9.5-9 AED: C8 PoD: C8.4-6 EDaP: C9.4-7
7	Constraints in rigid body motion Introduction to Analytical Mechanics	IDE: C8.1-6, C3.1 AED: C6.1 AD: C2.1, C5.1 PoD: C6.1-6 MoAD: C2.1
8	Lagrange's Equations for a particle – Traditional approach	AED: C6 AD: C2.1 PoD: C6 MoAD: C2.1-10
9	Lagrange's Equations for a particle – A new approach Connection to Newton's Laws	IDE: C3
10	Lagrange's Equations for a system of particles	IDE: C4
11	Lagrange's Equations for a rigid body	IDE: C10
12	Hamilton's Canonical equations for a particle	AD: C2.2-3 MoAD: C2.13

In the suggested readings above use the following key for suggested readings (see Resources in Section 7 below):

IDE: O'Reilly, *Intermediate Dynamics for Engineers*
AED: Ginsberg, *Advanced Engineering Dynamics*
AD: Greenwood, *Advanced Dynamics*
PoD: Greenwood, *Principles of Dynamics*
EDaP: O'Reilly, *Engineering Dynamics: A Primer*
MoAD: Meirovitch, *Methods of Analytical Dynamics*

5. Assessment

As much as is practicable, assessment in the course will be used to see if students have gained new ways of seeing, not to differentiate them from each other or to sort them. This is naturally limited by University rules concerning the grading of students and students desire to understand where they stand in relation to their peers.

Assessment task	**Length**	**Weight**	**Learning outcomes assessed**	**Assessment criteria**	**Due date, time, and submission requirements**
Problem Set 1	TBD	10%	1,2	Valid approach using course material to solve presented problems	Tuesday, Wk 4 18 Aug, 6 pm In person or by email
Problem Set 2	TBD	10%	2,3	Valid approach using course material to solve presented problems	Tuesday, Wk 7 8 Sept, 6 pm In person or by email
Problem Set 3	TBD	10%	3,4	Valid approach using course material to solve presented problems	Tuesday, Wk 10 6 Oct, 6 pm In person or by email
Problem Set 4	TBD	10%	3,4,5	Valid approach using course material to solve presented problems	Tuesday, Wk 13 27 Oct, 6 pm In person or by email
Individual Project	10 – 15 Pages	15%	1,2,3,4,5	Short report on a problem or topic chosen in agreement with lecturer. Will be assessed on presentation, analysis, and use of course-related material and techniques.	Friday, Wk 13 30 Oct, 5 pm In person or electronically
Mid-Semester Test	1 Hour	15%	2,3,5	All course content from weeks 1-6.	During Week 8 Lecture Time
Final exam	3 hours	30%	2,3,4,5	All course content from weeks 1-13	Exam period, date TBC

Problem sets and information about the Individual Project will be provided on Moodle.
Assignments

Presentation

All submissions should have a standard School cover sheet which is available from this subject's Moodle page.

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.

Submission

Assignments may be submitted as hard copies directly to the course convener during class times, consultation times, or otherwise by arrangement. Electronic submission is also accepted. Any other special submission instructions for specific assignments will be posted on the Moodle site for this course.

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.

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.

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 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

Recommended textbook (Available from the UNSW Bookshop):
O’Reilly, O.M., *Intermediate Dynamics for Engineers*, Cambridge University Press

Other suggested textbooks:
Ginsberg, J.H., *Advanced Engineering Dynamics*, 2nd Edition, Cambridge University Press
Greenwood, D.T., *Principles of Dynamics*, 2nd Edition, Prentice Hall
Greenwood, D.T., *Advanced Dynamics*, Cambridge University Press
Greenwood, D.T., *Classical Dynamics*, Dover Publications
Meirovitch, L., *Methods of Analytical Dynamics*, Dover Publications
O’Reilly, O.M., *Engineering Dynamics: A Primer*, Springer

These and many other relevant resources are available at the UNSW Library:
http://info.library.unsw.edu.au/web/services/services.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.

In this course, recent improvements resulting from student feedback include a total re-working of course content, teaching and assessment.

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: https://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.

Nathan M. Kinkaid
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