Australia's Global University

UNSW SYDNEY

Mechanical and Manufacturing Engineering

Course Outline

Semester 1 2018

MECH9223

MACHINE CONDITION MONITORING

Contents

1. Staff contact details

Contact details and consultation times for course convenor

Name: Pietro Borghesani
Office location: 408H, Level 4, Ainsworth building (J17)
Tel: (02) 9385 7899
Email: p.borghesani@unsw.edu.au
Moodle: https://moodle.telt.unsw.edu.au/login/index.php

For consultations, please arrange a suitable time with the Convenor, by writing an email to p.borghesani@unsw.edu.au

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

Dr Danish Haneef
Email: m.haneef@unsw.edu.au

Mr Dikang Peng
Email: dikang.peng@unsw.edu.au

For consultations, please arrange a suitable time with the demonstrators via email.

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

Lectures will run from week 1 to week 13 (with week 13 dedicated to review)
Demonstrations will run from week 2 to week 13

	Day	**Time**	**Location**
Lectures	Thursday	6pm – ~7.30pm	Central Lecture Block 6 (K-E19-103)
Demonstrations	Thursday	~7.30pm – 9pm	Ainsworth 203 (K-J17-203)

Summary and Aims of the course

This course is intended to provide the necessary tools and basic knowledge in the field of monitoring the health of rotating and reciprocating machines, primarily through vibration analysis.

The course starts with a brief introduction to the broad field of machine condition monitoring (MCM), including methods other than vibration analysis, as applied to the efficient maintenance of operating machines without disturbing their normal operation. Benefits of Condition Based Maintenance (CBM) over run to failure are mentioned. The course then concentrates on the measurement and analysis of vibration signals from operating machinery in both normal and faulty condition.

Vibration signals are generated by machines and machine components, such as gears and bearings. Appropriate signal processing techniques that can be used to extract symptoms of individual faults in individual components from the overall vibration signal.

The course applies the dynamic system modelling concepts that you learned in MMAN2300 and MMAN3200 and the Fourier methods introduced in MATH2019 (or their equivalents). A basic knowledge of mechanical vibration, as covered for example in the present MMAN2300 or in former courses MMAN3300 and MECH4305-9305, would be highly beneficial.

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.	Design the architecture of an appropriate condition monitoring system for typical machines, including hardware selection and measurement system setup.	PE1.1, PE1.2, PE1.3, PE1.5, PE2.3
2.	Understand, select and apply mathematical tools for the analysis of signals (e.g. Fourier Analysis)	PE1.1, PE1.2, PE2.2
3.	Program vibration analysis code to implement signal analysis and to extract fault symptoms of typical rotating and reciprocating machines.	PE1.3, PE2.2, PE2.3
4.	Diagnose typical machine faults based on the output of signal processing tools and recommend proper actions.	PE1.3, PE1.6, PE2.1, PE2.2
5.	Produce appropriate reports to communicate analysis results at a professional engineering level, including executive summary.	PE3.1, PE3.2, PE3.4

For learning outcome 3, MATLAB® has been chosen as the software for the implementation of diagnostic signal processing techniques. This software offers the benefits of being both highly flexible and strongly oriented towards mathematical applications. Moreover, it is probably the most used in advanced condition monitoring analysis.

4. Teaching strategies

Material in this course will be presented in Lectures and Demonstrations and complemented by material available on the Moodle website.

Topics are usually first introduced through PowerPoint® presentations and short document camera examples during the lecture time, together with examples of application and some guidelines for implementation.

Demonstration sessions occur immediately afterward and are designed for students to:

- apply the techniques and methodologies discussed in the lecture, including:
  - designing condition monitoring system architecture
  - using mathematical tools for function analysis (e.g. Fourier Analysis)
  - implementing signal processing techniques in MATLAB®
- analyse condition monitoring signals (simulated and/or experimentally measured) by means of MATLAB® programs developed by students
- evaluate the output of signal processing tools and diagnose typical machine faults

This will be done through problems and exercises that will be provided during the demonstration time, including MATLAB® examples. Assignment feedback will also be given during this time.

The Course Moodle page will contain:

- material presented in the class (Lectures and Demonstrations)

- Moodle quiz
- Assignment handouts
- additional material (e.g. notes, examples and practice problems) to foster and deepen your understanding of the topic and provide space to practice

This content is crucial for the course. More details about the importance of each will be given during lectures.

5. Course schedule

The following course schedule is indicative, and may be adjusted throughout the Semester. The suggested notes and book readings are indicative and details on the required/facultative readings will be given during the lectures.

Week	**Topic**	**Location**	**Suggested Readings**
1	Introduction to Machine Condition Monitoring	Lecture K-E19-103	Material on Moodle Randall Ch. 1.1 to 1.4
2	Vibration-Based CM	Lecture K-E19-103 Demos. K-J17-203	Material on Moodle Randall Ch. 1.5 to 1.6
3	Deterministic Signals and Fourier Analysis	Lecture K-E19-103 Demos. K-J17-203	Material on Moodle Randall Ch. 3.2.1 ad 3.2.2.
4	Digital implementation of Fourier Analysis (DFT)	Lecture K-E19-103 Demos. K-J17-203	Material on Moodle Randall Ch. 3.2.3, 3.2.4, 3.2.6, 3.4.8
5	DFT (cont'd) Typical low-shaft-harmonic faults	Lecture K-E19-103 Demos. K-J17-203	Material on Moodle Randall Ch. 3.2.3, 3.2.4, 3.2.6, 3.4.8, 2.2.1
6	Transfer function problems	Lecture K-E19-103 Demos. K-J17-203	Material on Moodle
7	Gear faults	Lecture K-E19-103 Demos. K-J17-203	Material on Moodle Randall Ch. 2.2.2, 3.3, 5.4
8	Random signals	Lecture K-E19-103 Demos. K-J17-203	Material on Moodle
9	Bearing diagnostics	Lecture K-E19-103 Demos. K-J17-203	Material on Moodle Randall Ch. 2.2.3, 3.3, 5.5
10	Variable speed, spectrogram	Lecture K-E19-103 Demos. K-J17-203	Material on Moodle Randall Ch. 3.7.1
11	CM applications and introduction to prognostics	Lecture K-E19-103 Demos. K-J17-203	Material on Moodle
12	CM applications and introduction to prognostics	Lecture K-E19-103 Demos. K-J17-203	Material on Moodle
13	Review	Lecture K-E19-103 Demos. K-J17-203	

6. Assessment

You will be assessed by means of four assessment tasks, detailed in the table below.

Assessment overview

Assessment	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
Moodle quiz	~ 10-15 questions	15% (15 marks)	1 and 2	All course content from weeks 1-3	Week 4 5pm Friday 23-March On Moodle	N/A	Monday 26-March
Assignment 1: Fourier Analysis	~ 10 pages	15% (15 marks)	2 and 3	Technical content (week 1-5)	Week 7 5pm Friday 20-April Submit on Moodle	5pm Monday 23-April	Two weeks after due date*
Assignment 2: Condition Monitoring Report	~ 20 pages	30% (30 marks)	1,2,3,4 and 5	Technical content (weeks 1-10) and report writing skills	Week 12 5pm Friday 19-October Submit on Moodle	5pm Thursday 25-October	Two weeks after due date*
Final exam	2 hours	40% (40 marks)	1,2,3 and 4	All course content from weeks 1-13	Exam period, date TBC	N/A	Upon release of final results

* For late submissions, two weeks after submission date

To pass the course, you must achieve an overall mark of at least 50%.

Assignments will be made available on the UNSW Moodle website along with data/material required to complete the assignment. Assignment 1 will be provided in week 4 and assignment 2 will be provided in week 7.

The Moodle Quiz will be opened in week 4 and detailed instructions on how to conduct the quiz will be given in the class and posted on Moodle in week 3.

Assignments

Presentation

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

Submission

Late submissions will be penalised 5 marks per calendar day (including weekends). An extension may only be granted in exceptional circumstances. Special consideration for assessment tasks must be processed through 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.

Where there is no special consideration granted, the 'deadline for absolute fail' in the table above indicates the time after which a submitted assignment will not be marked, and will achieve a score of zero for the purpose of determining overall grade in the course.

Marking

Marking guidelines for assignment submissions will be provided at the same time as assignment details to assist with meeting assessable requirements. Submissions will be marked according to the marking guidelines provided.

Examinations

There will be one two-hour examination at the end of the semester, covering all material.

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.

7. Attendance

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.

8. Expected resources for students

Required readings

Notes available on Moodle (except for the ones specifically tagged as “additional reading, not required”)

Recommended textbook

Randall, R. B. (2011). *Vibration-based condition monitoring: industrial, aerospace and automotive applications*. John Wiley & Sons.

Suggested additional readings

- Notes available on Moodle with the tag “additional reading, not required”
- D'Antona, G., & Ferrero, A. (2005). Digital signal processing for measurement systems: theory and applications. Springer Science & Business Media
- Rao, S.S., Mechanical Vibrations, 5th Edition, Prentice Hall, 2011.

UNSW Library website: https://www.library.unsw.edu.au/
Moodle: https://moodle.telt.unsw.edu.au/login/index.php

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.

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