MANF4430

Reliability and Maintenance Engineering

Term 1, 2022

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Ron Chan	r.chan@unsw.edu.au	Send Ron a text using Microsoft Team to book a private consultation session outside class time	Room ME507, Ainsworth Building	9385 1535

Lecturers

Name	Email	Availability	Location	Phone
Erik van Voorthuysen	erikv@unsw.edu.au	Send Erik a text using Microsoft Team to book a private consultation session outside class time	ME507, Ainsworth Building	9385 4147

School Contact Information

Location

UNSW Mechanical and Manufacturing Engineering

Ainsworth building J17, Level 1

Above Coffee on Campus

Hours

9:00–5:00pm, Monday–Friday*

*Closed on public holidays, School scheduled events and University Shutdown

Web

School of Mechanical and Manufacturing Engineering

Engineering Student Support Services

Engineering Industrial Training

UNSW Study Abroad and Exchange (for inbound students)

UNSW Future Students

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

(+61 2) 9385 4097 – School Office**

**Please note that the School Office will not know when/if your course convenor is on campus or available

Email

Engineering Student Support Services – current student enquiries

- e.g. enrolment, progression, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries

- e.g. admissions, fees, programs, credit transfer

School Office – School general office administration enquiries

- NB: the relevant teams listed above must be contacted for all student enquiries. The School will only be able to refer students on to the relevant team if contacted

Important Links

- Student Wellbeing
- Urgent Mental Health & Support
- Equitable Learning Services
- Faculty Transitional Arrangements for COVID-19
- Moodle
- Lab Access
- Computing Facilities
- Student Resources
- Course Outlines
- Makerspace

- UNSW Timetable
- UNSW Handbook

Course Details

Units of Credit 6

Summary of the Course

The course will introduce statistics, mathematics and associated techniques for analyzing an industrial process for the purpose of maintaining and improving it. Major disciplines covered include sensor hardware, data collection, data analysis including statistical process control, 6-sigma analysis and decision-making. The course focuses on developing experimental techniques using statistical methods to test the performance of the processes in a manufacturing industry. It lays the foundations for testing products, components, machinery and processes. This is necessary for the development of quality products. This leads to the development of quality assurance methods for products as well as the development and understanding of the reliability of the processes on the shop-floor. This is necessary to maintain maximum up-time and return-on-assets for a manufacturing facility.

Course Aims

This subject aims to develop the concept of data gathering, analysis and modeling using statistical methods. In attempting to determine if the processes or products are meeting set criteria the manufacturing engineer has to carry out tests that will enable him or her to make a judgment with a certain level of confidence.

The fundamental aim of the course is to present a comprehensive overview of methodologies and analyses in the fields of process improvement and reliability / maintenance engineering.

Reliability and maintenance management by definition are a collection of tools and methodologies to achieve machinery and process integrity and performance. One of the main foundations of reliability and maintenance engineering is that it is a top-down bottom-up driven strategy, regardless of the specific reliability and maintenance philosophies adopted. The aim is to provide students with a comprehensive overview of process improvement and maintenance strategies, methodologies and analytical foundations that form part of this important field.

The challenge for process improvement and maintenance engineering is to develop the most effective and at the same time efficient strategy for managing the performance, capability and condition of plant & equipment so as to meet or exceed commercial and operational requirements.

Course Learning Outcomes

After successfully completing this course, you should be able to:

Learning Outcome	EA Stage 1 Competencies
1. Understand the different statistical methods available for analysis of different processes	PE1.1, PE1.2, PE1.3
2. Understand the importance of the maintenance and process improvement functions within industry	PE2.1, PE2.2, PE2.3

Learning Outcome	EA Stage 1 Competencies
3. Understand the various methodologies used in industry to estimate the level of reliability and remaining life of a critical component and system at a certain point in time, using statistical and mathematical techniques where appropriate	PE1.2, PE2.1, PE2.2
4. Conduct reliability studies and make recommendations with respect to the maintenance plan and ongoing reliability program	PE3.1, PE3.4, PE3.6

Teaching Strategies

The course material will be presented in the form of synchronous online lectures and associated book chapters and readings. Understanding will be supplemented by case studies and examples discussed in class. Deeper understanding will be achieved during formal tutorial/lab sessions where students work with tutors and lecturer to implement theory on assigned problems and assignment case studies using Microsoft Excel, SAS, and Matlab. The mid-term quizzes will test the understanding of in-depth theory.

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Online Quiz x 4	40%	Wednesday Week 3, 5, 8, 10, 6PM Sydney Time	1, 2, 3
2. Group project x 2	60%	Week 7 and 10	1, 2, 3, 4

Assessment 1: Online Quiz x 4

Assessment length: 75 minutes
Due date: Wednesday Week 3, 5, 8, 10, 6PM Sydney Time
Deadline for absolute fail: Not Applicable
Marks returned: One week after completing the assessment unless supplementary

Students have to conduct 4 online Moodle quizzes during exam time according to the UNSW Timetable. Each quiz will worth 5% of their final assessment mark.

Assessment criteria

- Correct value entered (in filling-the-box questions)
- Correct choice of answer (in multiple choice questions)

Students are expected to submit their working out at the end each quiz. The working out can be in the form of handwritten notes, Excel files, Minitab files or equivalent that demonstrate the student's own work. A separate link will be provided for the submission of the working out.

Hurdle requirement

This course will include the following hurdle requirements that are closely linked to a set of learning outcomes which demonstrate that you have acquired the required skills and competencies within this discipline:

- Students must demonstrate understanding of reliability, both at the component as well as the system level. A minimum mark of 45% must be obtained for the combined marks of all 4 quizzes in order to pass this subjectin order to pass this subject. Failure to achieve this minimum mark will result in an unsatisfactory fail (UF) grade, regardless of the performance in the rest of the course.

According to the UNSW Assessment Policy and Procedure, no assessment can influence the course grade disproportionate to the assigned weighting. However, an exemption for allowing “hurdle” assessments can be used if the failure of an individual assessment task clearly demonstrates a failure to attain a professional competency from the course. If you have a hurdle assessment/requirement in your course, you may use the following paragraph and adjust the blue text as needed. Otherwise, please delete. For it to be a valid hurdle assessment, it has to be 1) an assessment which is a majority contributor to a particular learning outcome (i.e. in many cases there is a learning outcome which is only assessed by one assessment task) and 2) the learning outcome must be closely linked to a professional competency (i.e. EA competencies).

Assessment 2: Group project x 2

Start date: Week 4 and 7
Due date: Week 7 and 10
Deadline for absolute fail: 1 week after the assessment is due
Marks returned: 2 weeks after the assessment is due

Students will work in a team (min. 3, max. 4 members per team) to solve 2 separate real-life problems. Both involves uncovering information from a dataset. The dataset will contain performance data (simulated) based on an industry/real-life scenario.

Each project will consist of an (assessable) individual reflection component which students need to submit separete to their group report. A separate link on Moodle will be provided for this individual assessment.

Assessment criteria

Project 1

• Executive Summary – is the executive summary presented with high quality and accurate information with recommendation in plain English? (/2)

• Summary of Key Findings – provide a summary of your key finding in NON-STATISTICAL language (/3)

• Graphical Evidences – insert at least one appropriate data visualisation tool that supports each key finding (/5)

• Hypothesis Tests – provide a formal hypothesis test to support each key finding (/5)

• Recommendation – provide a concise and clear recommendation using NON-STATISTICAL language for each key finding (/5)

• Documentation – readability of the document (/5)

Project 2

• Executive Summary – is the executive summary presented with high quality and accurate information with recommendation in plain English? (/2)

• Summary of Key Findings – provide a summary of your key finding in NON-STATISTICAL language (/3)

• Graphical Evidences – insert at least one appropriate data visualisation tool that supports each key finding (/5)

• Reliability analysis and Cost Model – provide detail analysis to support each key finding (/10)

• Recommendation – provide a concise and clear recommendation using NON-STATISTICAL language

for each key finding (/5)

• Documentation – readability of the document (/5)

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

Course Schedule

View class timetable

Timetable

Date	Type	Content
Week 1: 14 February - 18 February	Lecture	**Issue analysis and data visualisation techniques (RC)** • Data-Driven Decision • Data Visualisation • Introduction to the Minitab Software • Basic Probability Distributions
Week 2: 21 February - 25 February	Lecture	**Statistical Hypothesis Testing (RC)** • Hypothesis Testing Revision • One-Tail vs Two-Tail t-test • One-Sample vs Two-Sample t-test • Paired t-test
Week 3: 28 February - 4 March	Lecture	**Linear Regression Analysis 1 (RC)** • Notations in ANOVA • Constructing ANOVA Table • Tukey's Comparison Test • Model Adequacy Checking
	Assessment	Online Quiz 1
Week 4: 7 March - 11 March	Lecture	**Linear Regression Analysis 2 (RC)** • Continuous vs Discrete Data • Two-way Table • Chi-Squares Test • Test of Independence
Week 5: 14 March - 18 March	Lecture	**Introduction to Probability Theory (RC)** • Basic probability revision • Venn diagram • Conditional probability
Week 6: 21 March - 25 March	Lecture	**Flexibility Week**

		• Revision • Assignment support
Week 7: 28 March - 1 April	Lecture	**Component reliability (EVV)** • Component vs System Reliability • Minimal Cut Set • Path Set Method • Fault Tree Method
	Assessment	Online Quiz 2
	Assessment	Project 1 Due
Week 8: 4 April - 8 April	Lecture	**System Reliability (EVV)** • P-F Curve • Major Degradation Modes • Inspection Intervals
Week 9: 11 April - 15 April	Lecture	**Physical Degradation Modeling (EVV)** • Reliability-Centred Maintenance (RCM) • Elements of Maintenance Strategy and Planning • Category of Maintenance Works • Maintenance KPIs
	Assessment	Online Quiz 3
Week 10: 18 April - 22 April	Lecture	**Maintenance Theory (EVV)** • Complex Process and System Characterisation • Data-Driven Model • Building Causal Network
	Assessment	Online Quiz 4

Resources

Prescribed Resources

• Babatunde A. Ogunnaike, Random phenomena : fundamentals of probability and statistics for engineers, CRC Press, 9950845363701731
• Douglas C. Montgomery, Design and analysis of experiments, 8th ed, Hoboken, N.J.: John Wiley & Sons, Inc., 1118146921
• Douglas C. Montgomery, Introduction to linear regression analysis, 5th ed, Hoboken, N.J.: John Wiley & Sons, Inc., 9781118627365
• Mohammad. Modarres, Reliability engineering and risk analysis : a practical guide, 2nd ed, Hoboken, CRC Press, 9950728008301731
• Sahay Amar, Data visualization. Volume 1, Recent trends and applications using conventional and big data, 1st ed, Business Expert Press, 9950811769301731

You can find a free e-copy of the textbook from the UNSW library.

Course Evaluation and Development

In this course, recent improvements resulting from student feedback include providing continuous assignment support.

Submission of Assessment Tasks

Assessment submission and marking criteria

Should the course have any non-electronic assessment submission, these should have a standard School cover sheet.

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.

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.

Late policy

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of 20 percent (20%) of the maximum mark possible for that assessment item, per calendar day, for a minimum of zero marks.

The late penalty is applied per calendar day (or part thereof), including weekends and public holidays, that the assessment is overdue.

Work submitted after the 'deadline for absolute fail' is not accepted and a mark of zero will be awarded for that assessment item. For example:

- Your course has an assessment task worth a total of **30 marks (Max Possible Mark)**
- You submit the assessment **2 days after the due date**
- The assessment is marked as usual and achieves a score of **20 marks (Awarded Mark)**
- The late policy is applied using **Late Mark = Awarded Mark - (Days*Penalty per Day)*Max Possible Mark**. Your adjusted final score is **8 marks** (20 - ((2*0.2)*30)).

For some assessment items, a late penalty may not be appropriate. These are clearly indicated in the course outline, and such assessments receive a mark of zero if not completed by the specified date. Examples include:

1. Weekly online tests or laboratory work worth a small proportion of the subject mark, or
2. Online quizzes where answers are released to students on completion, or
3. Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date, or
4. Pass/Fail assessment tasks.

Examinations

You must be available for all quizzes, tests and examinations. For courses that have final examinations, these are held during the University examination periods: February for Summer Term, May for T1, August for T2, and November/December for T3.

Please visit myUNSW for Provisional Examination timetable publish dates. For further information on

exams, please see the Exams webpage.

Special Consideration

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to submitting an assessment or sitting an exam.

UNSW now has a Fit to Sit / Submit rule, which means that if you attempt an exam or submit a piece of assessment, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

Please note that students will **not** be required to provide **any** documentary evidence to support absences from any classes missed **because of COVID-19 public health measures such as isolation**. UNSW will **not** be insisting on medical certificates from anyone deemed to be a positive case, or when they have recovered. Such certificates are difficult to obtain and put an unnecessary strain on students and medical staff.

Applications for special consideration **will** be required for assessment and participation absences – but no documentary evidence **for COVID-19 illness or isolation** will be required.

Special Consideration Outcomes

Assessments have default Special Consideration outcomes. The default outcome for the assessment will be advised when you apply for Special Consideration. Below is the list of possible outcomes:

Outcome	Explanation	Example
Time extension	Student provided more time to submit the assessment	e.g. 1 more week of time granted to submit a report
Supplementary assessment	Student provided an alternate assessment at a later date/time	e.g. a supplementary exam is scheduled during the supplementary exam period of the term
Substitute item	The mark for the missed assessment is substituted with the mark of another assessment	e.g. mark for Quiz 1 applied also applied as mark for Quiz 2, meaning if a student achieved a mark of 20/30 for Quiz 1 and was granted Special Consideration for Quiz 2, a mark of 20/30 would be applied for Quiz 2, etc
Exemption	All course marks are recalculated excluding this assessment and its weighting	e.g. The course has an assessment structure of: - Assignments 30%, - Lab report 30%, - Final Exam 40%. If the Lab report is missed and student is granted Special Consideration, then the assessment structure may be reweighted as follows: - Assignments 50% - Final Exam 50% as though the Lab report did not exist
Non-standard	Course Coordinator is contacted for the outcome when special consideration is granted as the outcome differs on a case-by-case basis	e.g. typical for group assessments where time extension supplementary assessment could be granted to the group member, time extension could be granted to the whole group, etc. Clarify with your Course Convenor for

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, visit: 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

Academic Information

Credit points

Course credit is calculated in Units-Of-Credit (UOC). The normal workload expectation for one UOC is approximately 25 hours per term. This includes class contact hours, private study, other learning activities, preparation and time spent on all assessable work.

Most coursework courses at UNSW are 6 UOC and involve an estimated 150 hours to complete, for both regular and intensive terms. Each course includes a prescribed number of hours per week (h/w) of scheduled face-to-face and/or online contact. Any additional time beyond the prescribed contact hours should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

On-campus class attendance

****T1-2022 UPDATE****
- -

Public distancing conditions must be followed for all face-to-face classes. To ensure this, only students enrolled in those classes will be allowed in the room. No over-enrolment is allowed in face-to-face classes. Students enrolled in online classes can swap their enrolment from online to on-campus classes by Sunday, Week 1. Please refer to your course's Microsoft Teams and Moodle sites for more information about class attendance for in-person and online class sections/activities.

Your health and the health of those in your class is critically important. You must stay at home if you are sick or have been advised to self-isolate by NSW health or government authorities. Current alerts and a list of hotspots can be found here. **You will not be penalised for missing a face-to-face activity due to illness or a requirement to self-isolate.** We will work with you to ensure continuity of learning during your isolation and have plans in place for you to catch up on any content or learning activities you may miss. Where this might not be possible, an application for fee remission may be discussed. Further information is available on any course Moodle or Teams site.

In certain classroom and laboratory situations where physical distancing cannot be maintained or there is a high risk that it cannot be maintained, face masks will be considered **mandatory PPE** for students and staff.

For more information, please refer to the
FAQs: https://www.covid-19.unsw.edu.au/safe-return-campus-faqs

Guidelines

All students are expected to read and be familiar with UNSW guidelines and polices. In particular, students should be familiar with the following:

- Attendance
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators

- Academic Honesty and Plagiarism

Image Credit

Photo by Stephen Blake March 2017, Willis Annexe (J18) Thermofluids lab

CRICOS

CRICOS Provider Code: 00098G

Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	✓
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	✓
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	✓
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering 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	
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	✓
PE3.2 Effective oral and written communication in 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	✓