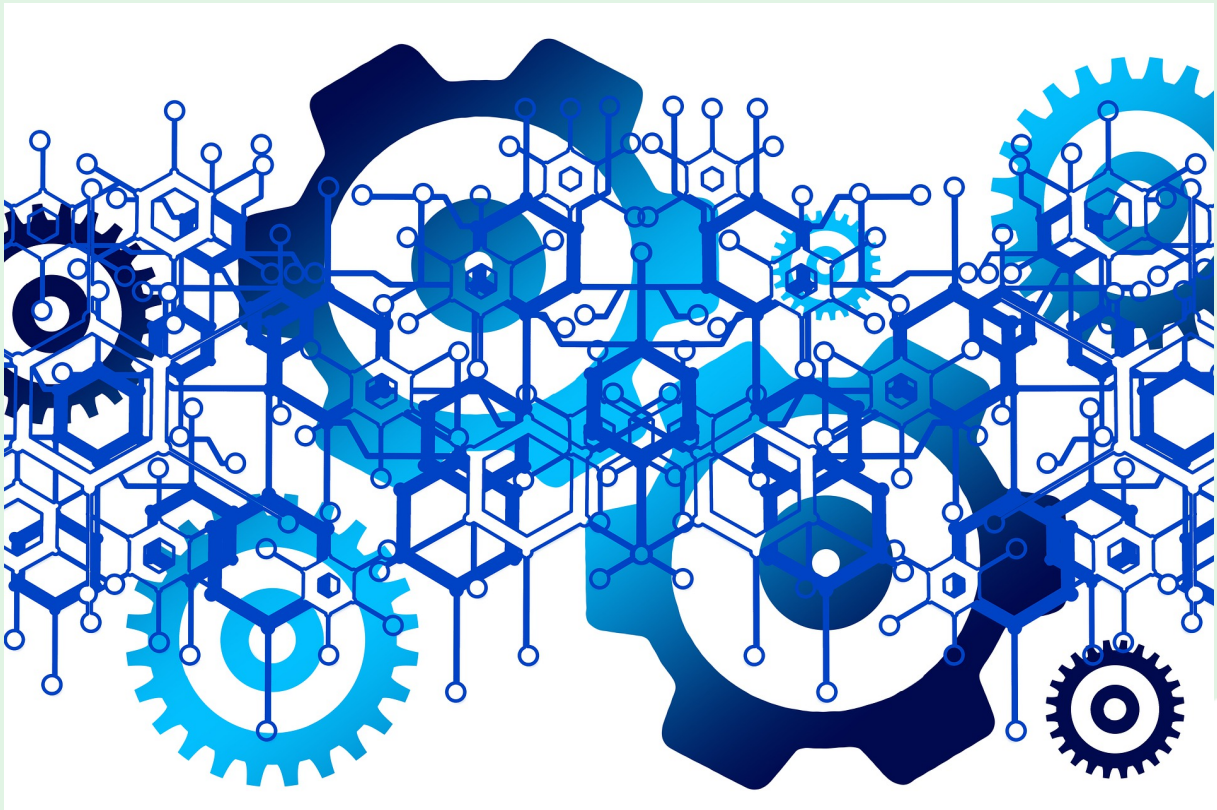
MMAN3200

Linear Systems and Control

Term 1, 2022



Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Mohammad Deghat	m.deghat@unsw.edu.au	By appointment (email or MS Teams)	Building J17, Room 510M	9385 1650

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

Models of physical systems: differential equations for physical systems including mechanical and electrical systems; linearisation. System analysis techniques: solution by Laplace transform method. Transfer functions and block diagrams. System response: response of first and second order systems to impulse step, ramp and periodic inputs; higher order system response; concept of system stability, applications. Concept of feedback control. Stability criteria; use of Root Locus and Bode for system analysis and modification. Simulation of linear and non-linear systems. The matrix exponential and state space notation. The transfer matrix. Pole and state feedback, controllability and observability. Use of MATLAB as a simulation environment.

The course is offered in terms 1 (T1) and 2 (T2). The majority of places in T1 will be reserved for Mechatronics students. The majority of places in T2 will be reserved for Aerospace, Mechanical and Mechanical and Manufacturing students.

Course Aims

Students will learn how to anaylse and design linear feedback control systems.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Create linear mathematical models on a variety of systems	PE1.1, PE1.3
2. Analyse linear time invariant continuous systems in both time- and complex- domains	PE1.2, PE2.1, PE2.2, PE1.5, PE1.6
3. Interpret and model systems through state space representation	PE1.2, PE2.1, PE2.2, PE1.6

Teaching Strategies

Please refer to the information in Moodle

Additional Course Information

Additional matters: Several necessary mathematical concepts learnt in MATH2018/2019 are regarded as prerequisite knowledge for MMAN3200, in particular the Laplace Transform, and Vector and Matrix Algebra. To assist students in revising those necessary concepts, the first tutorial revises the required mathematical knowledge. Academic staff will be glad to answer questions from students about these topics.

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Test	35%	Not Applicable	1, 2
2. Final Exam	45%	Not Applicable	1, 2, 3
3. Lab Report	20%	14/04/2022 06:00 AM	1, 2

Assessment 1: Test

Assessment length: Between 90 and 120 minutes for each Test.
Submission notes: Online tests
Deadline for absolute fail: 'N/A' for timed tests/quizzes
Marks returned: Within two weeks from the test.

There will be two components: Test 1 in Week 4 worth 0% (practice test for Test 2) and Test 2 in Week 5 worth 35%. Both tests are from the contents of Weeks 1-4.

Test 1 (0%) will be realeased on Thursday Week 4 (10 March). Soultions will also be given to students.

Test 2 (35%) is on Thursday 18:00 - 20:00 Week 5 (17 March). Marks are returned within 2 weeks after the test.

This is not a Turnitin assignment

Assessment criteria

See the course channel in MS Teams.

Assessment 2: Final Exam

Assessment length: 120 minutes
Deadline for absolute fail: 'N/A' for timed tests/quizzes.
Marks returned: The marks will be released at the same time when all marks for Term 2 are released.

Final examination focusing on the material covered in Weeks 5, 7-10.

This is not a Turnitin assignment

Additional details

The date and time of the final exam will be set centrally by the examination unit.

Assessment 3: Lab Report

Start date: 28/03/2022 06:00 AM
Assessment length: 20 pages maximum
Submission notes: Submission notes will be posted on Moodle and MS Teams.

Due date: 14/04/2022 06:00 AM
Marks returned: Marks will be returned within two weeks from the submission deadline.

Assignmnt description and marking criteria will be realsed on MS Teams in Week 7. This is an individual assignment.

This is not a Turnitin assignment

Additional details

The deadline for absolute fail is 19/04/2022 at 6:00 AM, five days after the standard deadline.

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	Topic	Introduction to feedback control. Differential equations describing electrical and mechanical systems. Definition of linear time invariant systems. Linearisation of nonlinear equations and operating curves.
Week 2: 21 February - 25 February	Topic	Laplace transform and inverse Laplace Transform. Use of tables. Concept of transfer function. Input-output relations. Reduction of block diagrams. Simple rules for manipulations.
Week 3: 28 February - 4 March	Topic	Impulse, step, ramp and sinusoidal inputs. Transient process and the steady state. The time constant, percentage overshoot, settling time.
Week 4: 7 March - 11 March	Topic	The pole position and its relation to stability and other performance characteristics. Open and closed loop systems. Negative feedback loops. Steady state errors of closed loop systems.
	Assessment	TEST 1 (0%): Preparation for Test 2 in Week 5.
Week 5: 14 March - 18 March	Lecture	Root Locus approach. Rules for creating root locus. Routh-Hurwitz stability criterion. Frequency Response of LTI systems. Bode plots. Gain Margin and Phase Margin. Bandwidth.
	Assessment	TEST 2 (35%).
Week 6: 21 March - 25 March	Topic	**Flexibility week:** No lectures and tutorials.
Week 7: 28 March - 1 April	Lecture	PD, PI and PID controllers, definition and analysis via Root Locus and Bode. State space representation. Process model of LTI systems. SISO and MIMO systems. Non linear cases. Linearization of non linear process models.

Week 8: 4 April - 8 April	Lecture	Transfer function (For LTI SISO and MIMO cases). Controllable canonical form. Similarity transformation. Solution of state space equation. Matrix exponential.
Week 9: 11 April - 15 April	Lecture	Stability analysis, eigenvalues. State feedback. Pole placement. Controllability.
Week 10: 18 April - 22 April	Lecture	State estimation. Observers. Observability. Implementing state feedback via estimated states. Revision

Resources

Prescribed Resources

Lecture slides are provided, as well as sets of tutorial problems.

Example code of simulations in Matlab and Simulink will be provided too.

UNSW Library website: https://www.library.unsw.edu.au/

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

Recommended Resources

The main textbook for the course will be:

- "Feedback Control of Dynamic Systems", G. Franklin J. Powell, A. Emami-Naeini, 8th Edition
    - Print: https://www.bookshop.unsw.edu.au/details.cgi?ITEMNO=9781292274522
    - Digital: https://unswbookshop.vitalsource.com/products/-v9781292274546

Another **optional reference** is:

- "Feedback Systems: An Introduction for Scientists and Engineers", Aström and Murray, 2nd Edition.
    - This book is available for free at: http://www.cds.caltech.edu/~murray/amwiki/index.php/Second_Edition

Course Evaluation and Development

Feedback on the course is gathered periodically using various means, including the UNSW myExperience process, informal discussion during the lecture and tutorials, 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.

The course is completely revised in T1 2022 with new lecture slides, problem sets, Kahoot question and a new assignment.

Laboratory Workshop Information

Due to the uncertainties with the pandemic, two different options are prepared. One will be an assignment based on MATLAB simulation that requires no physicl acess to the lab(s), the other one will have a remote and or physical access to Lab 212A J18. (Willis annex).

Either way, this will be an individual piece of assessment.

Full information will be provided closer to the lab time.

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

N/A

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	