Mechanical and Manufacturing Engineering

Course Outline

Term 2 2020

MMAN3200

LINEAR SYSTEMS AND CONTROL

Contents

1. Staff contact details

Contact details and consultation times for course convenor

Name: Dr Zoran Vulovic
Tel: (02) 9385 6261
Email: z.vulovic@unsw.edu.au
Moodle: https://moodle.telt.unsw.edu.au/login/index.php
Microsoft Teams Video Chat Hours: TBA

*The preferred mode of consultations is **MS Teams** video chat. The times will be announced during Week 1. The **Moodle** discussion forum is an equally acceptable method as you will be able to get the answer outside the consultation times. **Face-to-face** consultations are possible in* Dr Vulovic's office *(*Ainsworth Building, Room 311D), but a prior appointment is recommended. The current restrictions allow only one visitor at the time with strict social distancing. **Email and telephone** can also be used for solving more general issues.

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

Name: Dr Jose Guivant (lecturing the Control component)
Office: Room 510D, Building J17
Tel: (02) 9385 5693
Email: j.guivant@unsw.edu.au
Microsoft Teams Video Chat Hours: TBA

Consultation with Dr Guivant concerning this course will be announced later.

Please see the course Moodle.

2. Important links

- Moodle
- Lab Access
- Health and Safety
- Computing Facilities
- Student Resources
- Course Outlines
- Engineering Student Support Services Centre
- Makerspace
- UNSW Timetable
- UNSW Handbook
- UNSW Mechanical and Manufacturing Engineering

3. Course details

Credit points

This is a 6 unit-of-credit (UoC) course and involves 8 hours per week (h/w) of scheduled online contact.

The normal workload expectations of a student are approximately 25 hours per term for each UOC, including class contact hours, other learning activities, preparation and time spent on all assessable work.

You should aim to spend about 17 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**	**Delivery Mode**
Lectures	Tuesday	9.00-12.00	Microsoft Teams Live Event
Lectures	Wednesday	15.00-18.00	Microsoft Teams Live Event
Demonstrations	Please check your timetable	Please check your timetable	Microsoft Teams Chat Channel
Lab	N/A	N/A	See Moodle for details
Tests	Monday	18.00pm – 20.00pm, Weeks 3 and 7	On-line, see Moodle for details

All classes in T2 2020 will be online. Please consult this course's Moodle module for details about delivery.

Summary and Aims of the course

The primary function of Linear Systems and Control is to serve as the first step towards mastering control engineering. The ultimate purpose of control engineering is to approach various systems from the stability point of view, with special attention given to transient processes. With that in mind, MMAN3200 endeavours to provide students with analytical tools that are easily applied to a wide spectrum of engineering problems.

Some components of this module have other roles. Systems modelling for example, which occupies a major part, helps you acquire knowledge necessary for simulation, analysis or design of numerous systems. It helps you consolidate the knowledge gained so far in courses dealing with Mechanics, Design, Fluids, Thermodynamics, Solids and Electrical Engineering. Linearisation provides a useful tool for simplification of complex systems while at the same time points out possible problems that could arise from oversimplification. In the

latter part of the course, you will learn state space analysis, a powerful and general technique for studying dynamic systems.

The aim of MMAN3200, as an important part of control engineering, is to offer the knowledge of methodologies specifically designed for Laplace domain, which in turn enables easier and more efficient analysis of complex engineering systems. Numerous types of systems from real engineering applications will be used throughout the course to give you the practical aspects of the methods covered.

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.	Create linear mathematical models of a variety of systems;	PE1.2, PE2.1, PE2.2
2.	Analyse linear time invariant continuous systems in both time- and complex- domains;	PE1.2, PE2.1, PE2.2

4. Teaching strategies

Lectures in the course are designed to provide the basic theory behind the concepts taught. For most classes, lecture notes slides will be available online and beforehand. Students are encouraged to ask questions during the classes.

It is very important for third year students to be able to use multiple sources. For that reason, apart from the textbook, several recommended texts are listed. You are welcome to consult your lecturers on this.

Demonstrations are designed for practical applications of the theoretical concepts introduced in lectures. A comprehensive set of tutorial problems will be provided beforehand. Two types of demonstrations will be organised, standard and interactive.

In “standard” demonstrations, it is the demonstrator who sets the pace and works on select examples. The times of those classes are found in your timetables.

In ‘interactive” demonstrations, it is students who work individually or in small groups, and therefore it is up to them to select the examples and dictate the pace. The demonstrators and the lecturer will be on hand to provide guidance. These demonstrations will run in the last 45-60 minutes of each lecture block.

Finally, the lab exercises are important in giving you the practical aspects of some of the

concepts learnt in classes. This year the experiment will be filmed and the data collected will be provided to students to complete the analysis and submit the report.

5. Course schedule

Date	Topic	Lecture Content	Demonstration/ Lab Content	Suggested Readings
Week 1	Classification of engineering systems Linearisation. Laplace transform.	Linearisation of non-linear equations and operating curves. Laplace transform and inverse Laplace Transform. Initial and final value theorems. Shift theorems. Use of tables	Tutorial Set I Tutorial Set II	Class readings
Week 2	Mathematical models of components and simple systems.	Mechanical, electrical, thermal and fluid components. Input-output relations. Differential equations describing simple systems.	Tutorial Set III	Class readings
Week 3	Quiz. Mathematical models of complex systems. Use of block diagrams.	Mathematical models of complex systems by combining simultaneous equations associated with the physical model. Reduction of block diagrams. Simple rules for manipulations.	Tutorial Set III and IV	Class readings
Week 4	Time response of first and second order systems. Performance criteria. Analysis in the s-plane.	Impulse, step, ramp and sinusoidal inputs. Transient process and the steady state. The time constant, percentage overshoot, rise time, settling time. The pole position and its relation to stability and other performance characteristics.	Tutorial Sets V and VI	Class readings
Week 5	Concept of control. Steady state errors. Root locus.	Open and closed loop systems. Negative feedback loops. Steady state errors of closed loop systems. Rules for creating root locus.	Tutorial Sets VI and VIII	Class readings
Week 6	Flexibility week	Revision	N/A	N/A

Date	Topic	Lecture Content	Demonstration/ Lab Content	Suggested Readings
Week 7	Mid-semester test. PID controllers.	Definitions and applications of PID controllers	PID controllers	Class readings
Week 8	Frequency based control system design	Bode diagrams; resonant frequency, resonant peak value, gain/phase margin, bandwidth; basic factors, gain, integral/derivative factors, first-order factors	Bode diagrams.	Class readings
Week 9	State space design – Part A.	State-space representation; transfer function, controllable canonical form, solution of state space equation.	State-space analysis, eigenvalues, transition matrix.	Class readings
Week 10	State space design – Part B. Contingency time	Controllability, pole placement design, substitution method, Ackermann's method. Approximated discrete time models, for non-linear cases.	Pole placement design; transform method, Matlab simulation	Class readings

6. Assessment

Assessment overview

Assessment	**Group Project?** (# Students per group)	**Length**	**Weight**	**Learning outcomes assessed**	**Assessment criteria**	**Due date and submission requirements**	**Deadline for absolute fail**	**Marks returned**
Tests	No	50 minutes and 100 minutes respectively	35% (10% and 25% respectively)	1 and 2	Topics assessed include the lectures in Weeks 1-2 and 1-5 respectively	Monday 15th June 6:00pm; Monday 13th July 6.00pm	N/A	Two weeks after the test
Lap report	No	8 pages	20%	1 and 2	Lecture material from Weeks 1-7	Sunday 2nd August 11:50pm via Moodle	Friday 7th August	Two weeks after submission
Final exam	No	1.5 hours	45%	1 and 2	All course content from weeks 1-10 inclusive.	Exam period, date TBA	N/A	Upon release of final results

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

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.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day.

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

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:

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

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

You must be available for all quizzes, tests and examinations.

Final examinations for each course 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 and supplementary assessment

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.

Please note that 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.

7. Expected resources for students

Textbook

Ogata, K. "Modern Control Engineering" (Copies are available in the UNSW library.)

Recommended texts

Palm, W. J. "Modelling, Analysis, and Control of Dynamic Systems"

J. Wilkie, M. Johnson and R. Katebi, "Control Engineering - an introductory course," Palgrave.

N. S. Nise, "Control Systems Engineering," Wiley.

F. Powell and E. Naeini, "Feedback Control of Dynamic Systems," Addison Wesley.

(Most of these books are available in the library)

Lecture notes

Lecture notes and tutorials are going to be available on Moodle before the class.

Other Resources

Although most of the material taught in the course is covered in the textbook, some deviations are inevitable. If you wish to explore any of the lecture topics in more depth, then other resources are available and assistance may be obtained from the UNSW Library.

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

8. 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.

Much of the last year's feedback is not applicable this year due to the forced conversion to on-line delivery this year. Still, one important improvement from last year is made by providing up to two hours of interactive demonstrations per week. This should enable students to work on tutorial problems independently while utilising the demonstrators' assistance as soon as a problem is encountered.

9. 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

10. Administrative matters and links

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
- Equitable Learning 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