Mechanical and Manufacturing Engineering

Course Outline

Term 2 2020

MTRN3020

MODELLING AND CONTROL OF MECHATRONIC SYSTEMS

Contents

1. Staff contact details

Contact details and consultation times for course convenor

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Moodle: https://moodle.telt.unsw.edu.au/login/index.php
Microsoft Teams Video Chat Hours: Tuesdays and Thursdays 2 – 3 pm

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

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 3 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 15 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	Tuesdays	12 pm – 2 pm	Microsoft Teams Classroom
(Web stream)	Any	Any	Moodle
Tutorials			
(Weeks 1 - 10)	Thursday	1 pm – 2 pm	Microsoft Teams Classroom
Labs/Quizzes			
(Weeks 4, 8, 10, 11 only)	Mondays	12 pm – 2 pm	Moodle/Microsoft Teams

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

This course teaches the student how to design and develop a control system in discrete-time domain to be used in motion control systems. Material covered includes; Revision of continuous-time control systems and design tools such as root locus, bode methods and Laplace transform. Starred Laplace transforms, z-transforms. Discretising continuous-time systems. Stability, speed of response and accuracy. Controller design using; root-locus method, direct and indirect analytical methods and bode methods. Observability, controllability. State estimators and design of observers.

This course will give you a thorough understanding of computer-controlled systems. Its core content can be broadly categorized into mathematical means of modelling Mechatronic Systems, model validation, design of digital controllers using a variety of different methods and the implementation of controllers on real-life systems. The systems being modelled and controlled are largely motion control systems.

The course has laboratory experiments (i) to model an inverted pendulum system and to design a classical controller (ii) to design digital control systems for speed and position control rigs.

The courses in the Mechatronics discipline are built up on four different areas: mechanical design, computing, electronics and microprocessors, and control systems. The latter three areas are interrelated, and this course forms a cornerstone of the fundamental courses on which the Mechatronic Engineering course at UNSW is built upon. A thorough understanding of the control of dynamical mechanical systems to achieve desired motions is essential for the design and development of any sophisticated Mechatronic System. Using the fundamental classical control system knowledge gained in the third year, this course builds your knowledge on designing and implementing computer-controlled systems. Control systems provide a methodical way of carrying out the motion control that also needs programming and computing. As such the contributions from this course to the Mechatronic Engineering degree program are essential and vital.

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.	Develop an understanding of the purpose of control systems and their use.	PE1.1
2.	Be able to understand that a plant is given and a control system is to be designed to satisfy performance specifications.	PE1.1
3.	Be thoroughly conversant with the available design methodologies and have the ability to choose the appropriate design methods to design a control system.	PE2.2
4.	Have a thorough understanding of the control system application environment and be able to implement the designed control systems.	PE2.3

4. Teaching strategies

Teaching of this course is through Microsoft Team Classrooms. The majority of the lecture content is available as pre-recorded videos. The students are expected to watch these pre-recorded videos and complete minor quizzes before the lecture time. The minor quizzes will award marks. During the lecture time a brief explanation of the weekly content is given and then students get an opportunity work out sample problems. Tutorial classes will also take place in Microsoft Teams classrooms. Laboratory exercises will be explained and data sets for individual students will be provided.

The tutorial sessions are designed to help you use tools such as Matlab to solve complex control system problems. It is essential that you have access to Matlab during all online sessions so that you can maintain a seamless continuation of your learning. The provision of the learning environment in the online tutorial sessions is to facilitate developing confidence in managing design tasks as projects. The content delivered in the lectures will be used to design controllers and then to apply them to control *models* of real-life systems.

5. Course schedule

Week	Topic	Location	Suggested Readings
1	Introduction and How Control Systems Work	Microsoft Team classroom	Refer to the week 1 on Moodle and watch the videos if any
2	Modelling, Transfer Functions and State Space Representation	Microsoft Team classroom	Refer to the week 2 on Moodle and watch the videos if any
3	Root Locus followed by Introduction to Discrete-Time Systems	Microsoft Team classroom	Refer to the week 3 on Moodle and watch the videos if any
4	z-transforms and Discrete-Time Transfer Functions	Microsoft Team classroom	Refer to the week 4 on Moodle and watch the videos if any
5	Stability followed by Discrete Equivalents of Continuous-time Systems	Microsoft Team classroom	Refer to the week 5 on Moodle and watch the videos if any
6	Flexibility Week		
7	Direct Design: Discrete Controller Design Using Root Locus	Microsoft Team classroom	Refer to the week 7 on Moodle and watch the videos if any
8	Direct Design: Discrete Controller Design Using Direct Analytical Method	Microsoft Team classroom	Refer to the week 8 on Moodle and watch the videos if any
9	Indirect Design: Discrete Controller Design Using Bode Method	Microsoft Team classroom	Refer to the week 9 on Moodle and watch the videos if any
10	State Feedback Controllers and Observers	Microsoft Team classroom	Refer to the week 10 on Moodle and watch the videos if any

6. Assessment

Assessment overview

Task	Assessment	Group Project?	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
T1	Pendulum experiment†	No	A full report as per submission specifications.	10%	1 and 2	Refer to laboratory specification for exact details.	Submit electronically to Moodle submission site by 11.59 pm of 10 July 2020 (Week 6 Friday)	11.59 pm of 15 July 2020	By midnight of Friday of week 7
T2	Speed Control Experiment†	No	A full report as per submission specifications.	15%	3 and 4	Refer to laboratory specification for exact details.	Submit electronically to Moodle submission site by 11.59 pm of 7 August 2020 (Week 10)	11.59 pm of 12 August 2020	By midnight of Friday of week 11
T3	Position Control Experiment†	No	A full report as per submission specifications.	20%	3 and 4	Refer to laboratory specification for exact details.	Submit electronically to Moodle submission site by 11.59 pm of 21 August 2020 (week 12)	11.59 pm of 16 August 2020	By midnight of Friday of week 13
T4	Quiz* (Parts 1, 2 &3)	No	10, 10 and 25 MCQ/Short answer questions	55% (10%+15%+20%+10% respectively)	1,2,3 and 4	Content of weeks 1-3, 4-7, 8-10	From Mondays 12 pm to 2 pm of weeks 4, 8 and 11	N/A	Immediately
	Lecture video quizzes	No	10 weekly lecture video quizzes			Content for Weeks 1-10	Weekly 1 hour before the lecture (unsupervised)	N/A	immediately

Assignments

Detailed laboratory assignment tasks will be made available from week 2 of the term in the course Moodle pages. For lab experiments, each student will receive his/her own personalized data. It is essential that each student use his/her personalized data in his/her reports.

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. This course has no final examination.

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

Recommended Textbooks

1. Dorsey, J., "Continuous and Discrete Control Systems", McGraw Hill
2. Golten, J. and A. Verwer, "Control System Design and Simulation" McGraw Hill

Additional Readings

Worked solutions to computer lab exercises will be made available in the Moodle page for MTRN3020.

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.

In this course, recent improvements resulting from student feedback include complete digital uplifting of the course.

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.](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