# MTRN3020

## Modelling and Control of Mechatronic Systems

Term One // 2021

School of Mechanical and Manufacturing Engineering // UNSW Engineering

# Course Overview

|  |  |  |  |  |
|---|---|---|---|---|
|  |  |  |  |  |

|  |  |  |  |  |
|---|---|---|---|---|
|  |  |  |  |  |

(+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

# Course Details

## Credit Points 6

## Summary of the Course

This subject teaches the student how to design and develop control systems in discrete-time domain that can 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.

## Course Aims

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.

## Course Learning Outcomes

Course Learning Outco s ieve r the de he

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

| Learning Outcome | EA Stage 1 Competencies |
|---|---|
|  |  |
|  |  |
|  |  |
|  |  |

| Learning Outcome | EA Stage 1 Competencies |
|---|---|
| application environment and be able to implement the designed control systems. | |

The experimental content and the associated video content will help the students appreciate how control systems work. In a group setting, students will be able to observe, how controllers of their peers operate with different controller parameters  demonstrating different behaviours.

## 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. After watching the video content, the students are also expected to attempt the sample problems given to them before the lecture, which will be discussed and worked out during the lectures. During the lecture time a brief explanation of the weekly content is also 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.

## Additional Course Information

The students who come to follow this course are required to have prior knowledge from MMAN3200 Linear Systems and Control or a similar course.

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.

# Assessment

## Assessment Tasks

| Assessment task | Weight | Due Date | Student Learning Outcomes Assessed |
|---|---|---|---|
| Quiz : Lecture Video Quizzes | 10% | Not Applicable | |
| Quiz : Major Quiz Part 1 | 10% | TBA | 1, 2 |
| Lab 1 : Inverted Pendulum Experiment | 10% | 29/03/2021 11:59 PM | 1, 2 |
| Lab 2: Speed Control Experiment | 15% | 16/04/2021 11:59 PM | 1, 2, 3 |
| Quiz : Major Quiz Part 2 | 15% | TBA | 1, 2, 3 |
| Lab 3: Position Control Experiment | 20% | | |
| | | | |

Details:The students will be required to design a controller and implement it on an actual experimental rig. The experimental rig consists of an inverted pendulum and the control systems designed by each individual student is expected to hold the pendulum steady while the cart on which it is mounted moves. The data collected for each student will be made available for them and they must complete a report.

Submission notes: Students must submit a report as per the experiment specification.

Turnitin setting: This assignment is submitted through Turnitin and students do not see Turnitin similarity reports.

Assessment 4: Lab 2: Speed Control Experiment

Start date: The laboratory classes will take place during week 7

Details:The students will be required to design a controller and implement it on an actual experimental rig. The experimental rig consists of a speed control system and the control systems designed by each individual student is expected to maintain the speed of the system despite load variations. The data collected for each student will be made available for them and they must complete a report.

Submission notes: The students must write a report as per the position control experiment specification

Turnitin setting: This assignment is submitted through Turnitin and students do not see Turnitin similarity reports.

Assessment 5: Quiz : Major Quiz Part 2

Start date: 09/04/2021 06:00 PM

Details:This quiz will be conducted in Week 8 Friday between 6 and 7 pm. This is a compulsory quiz and will cover all content covered in weeks 4 - 7 (including material presented in pre-lecture videos, lecture videos, tutorial classes and lab classes if any). The conditions under which this quiz will be conducted will be announced closer to the quiz.

Assessment 6: Lab 3: Position Control Experiment

Start date: The experiment will take place in week 9

Details:The students will be required to design a controller and implement it on an actual experimental rig. The experimental rig consists of a position control system and the control systems designed by each individual student is expected to position a rotating arm accurately. The data collected for each student will be made available for them and they must complete a report.

Submission notes: The students must write a report as per the position control experiment specification

Turnitin setting: This assignment is submitted through Turnitin and students do not see Turnitin similarity reports.

Assessment 7: Quiz : Major Quiz Part 3

Start date: 23/04/2021 06:00 PM

Details:This quiz will be conducted on Week 10 Friday between 6 and 7 pm. This is a compulsory quiz and will cover all content covered in weeks 8 - 10 (including material presented in pre-lecture videos, lecture videos, tutorial classes and lab classes if any). The conditions under which this quiz will be conducted will be announced closer to the quiz.

| | | |
|---|---|---|
| Week 9: 12 April - 16 April | Assessment | Week 9 Minor quiz |
| | Tut-Lab | Position Control Experiment |
| | Lecture | Indirect Design: Discrete Controller Design Using |
| | | |
| | | |
| | | |
| | | |
| | | |

Ap6 Me r qui - 1

# Resources

## Prescribed Resources

Pre recorded lecture videos and lecture notes will be made available on Moodle.

## Recommended Resources

The following text books may be used for reference.

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

## 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.

## Laboratory Workshop Information

All laboratory classes will take place in Room 204 of Willis Annex.

# 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.

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:

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.

# 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. *Nj_eg_pgqk _r SLQU gq bcdglcb _q sqgle rfc umpbq mp gbc_q md mrfcpq _lb n_qqgle rfck mdd _q wmsp mul,*

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

Important Links