UNSW SYDNEY | Australia's Global University

Mechanical and Manufacturing Engineering

Course Outline

Semester 2 2017

MTRN3020

Modelling and Control of Mechatronic Systems

Contents

1. Staff contact details

Contact details and consultation times for course convenor

Name: Associate Professor Jay Katupitiya
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Consultation times: See News Forum after the start of the course.

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

Please see the course Moodle.

2. Important links

- Moodle
- UNSW Mechanical and Manufacturing Engineering
- Course Outlines
- Student intranet
- UNSW Mechanical and Manufacturing Engineering Facebook
- UNSW Handbook

3. Course details

Credit Points

This is a 6 unit-of-credit (UoC) course, and involves four hours per week (h/w) of face-to-face contact.

The UNSW website states “The normal workload expectations of a student are approximately 25 hours per semester for each UoC, including class contact hours, other learning activities, preparation and time spent on all assessable work. Thus, for a full-time enrolled student, the normal workload, averaged across the 16 weeks of teaching, study and examination periods, is about 37.5 hours per week.”

This means that you should aim to spend about 9 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	Location
Lectures	Monday	10am – 12 pm	Colombo Theatre B
Tutorials	Monday	9 am – 10 am	Ainsworth 203 and 204
Demonstrations	Tuesday	11 am – 2 pm	MTRN212
	Wednesday	9 am – 12 pm	MTRN212
	Wednesday	2 pm – 5 pm	MTRN212
	Thursday	12 pm – 3 pm	MTRN212
	Thursday	9 am – 11 am	MTRN212
	Friday	11 am – 2 pm	MTRN212

Please refer to your class timetable for the learning activities you are enrolled in and attend only those classes.

Summary and Aims of the course

This course focuses on the design of digital control systems and their implementation on linear time invariant systems.

This course will give you a thorough understanding of computer controlled systems. Its core content can be broadly categorized into mathematical and experimental 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 to model a monorail crane system and to design and implement digital control systems on speed and position control rigs.

The courses in the Mechatronics discipline are built upon four different areas. They are: 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 high level of programming skills is necessary to develop customised interface routines to communicate with/control various elements of Mechatronic systems. This knowledge is essential in programming control systems and developing software modules for the interfacing of various hardware elements together to form complete Mechatronic Systems. As such, the contributions from this course to the Mechatronic Engineering degree program are absolutely essential and vital.

Student learning outcomes

This course is designed to address the below learning outcomes 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 Comprehensive, theory-based understanding of underpinning fundamentals
2.	Be able to understand that a plant is given and a control system is to be designed to satisfy performance specifications.	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals
3.	Be thoroughly conversant with the available design methodologies and have the ability to choose the appropriate design methods to enable the control system design.	PE2.2 Fluent application of engineering techniques, tools and resources
4.	Have a thorough understanding of the control system application environment and be able to implement the designed control systems.	PE2.3 Application of systematic engineering synthesis and design processes

4. Teaching strategies

Teaching of this course is through lectures, demonstrations and laboratory sessions. All laboratory work is individual work and attendance is essential.

The provision of the learning environment in the laboratory is to facilitate you to develop confidence in managing laboratory tasks as projects. Demonstrators in the laboratories are there to provide you guidance and assistance in managing the laboratory tasks.

5. Course schedule

Topic	Mondays (10 am – 12 pm)	Location	Lecture Content	Demo/ Lab	Suggested Readings
Introduction	Week 1	Colombo B	Mechatronic Systems, Computer Controlled Systems, Mathematical Modelling of Systems, System Identification, Design of Discrete Time Control Systems, Use of Design Packages, Rapid Controller Prototyping, Implementation of Control Algorithms	None	Moodle lecture notes

Topic	Mondays (10 am – 12 pm)	Location	Lecture Content	Demo/ Lab	Suggested Readings
Automatic Control Systems	Week 2	Colombo B	Classical Control Systems, Terminology, Feedback versus Feed forward, Qualitative and Quantitative Analyses of Proportional, Integral and Derivative Controllers. Simulation of Classical Control Systems.	None	Moodle lecture notes
s-Domain to z-Domain	Week 3	Colombo B	z-transforms, Inversion Techniques, Pulse Transfer functions.	None	Moodle lecture notes
Computer Controlled Systems	Week 4	Colombo B	Signal Types, Samplers, Analogue to Digital Controllers, Digital to Analogue Controllers, PWM Amplifiers, Encoders, Actuators, Mathematical Representation of these Elements.	None	Moodle lecture notes
Modelling of Mechatronic Systems	Week 5	Colombo B	Mathematical Modelling of a DC Servo Motor Driving a Positioning System, Experimental System Identification of a Linear Robot Axis. Conversion of Continuous Time Models to Discrete Time Models.	None	Moodle lecture notes
Design Methods for Discrete Time Controllers	Week 6	Colombo B	Root Locus Method, Direct Design Method	None	Moodle lecture notes
Design Methods for Discrete Time Controllers	Week 7	Colombo B	Indirect Design Method, State Space Method	None	Moodle lecture notes
Design Methods for Discrete Time Controllers	Week 8	Colombo B	Design of a Position Controller, Design of a Speed Controller, Real-Time Implementation of Controllers..	None	Moodle lecture notes
Design and Implementation of Controllers	Week 9	Colombo B	Design of a Position Controller, Design of a Speed Controller, Real-Time Implementation of Controllers.	None	Moodle lecture notes
Controllability and Observability	Week 10	Colombo B	Determining observability and controllability of a system	None	Moodle lecture notes
Estimators	Week 11	Colombo B	Predictive and current observer design	None	Moodle lecture notes
Revision	Week 12	Colombo B	Revision	None	Moodle lecture notes

6. Assessment

Assessment overview

Assessment	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
Online quiz on basic control system features and their functioning	Online MCQ- 10 questions	0%	1 and 2	Must complete to qualify for remaining assessments	Must complete by 11.59pm of 25 August 2017	11.59 pm of 25 August 2017	At the time of completing the assessment
Monorail crane modelling experiment†	A full report as per submission specifications.	15%	1 and 2	Refer to laboratory specification for exact details.	Submit electronically to Moodle submission site by midnight of Friday Week 7	11.59 pm of Monday of Week 8	By midnight of Friday of week 9
Speed Control Experiment†	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 midnight of Friday Week 9	11.59 pm of Monday of Week 10	By midnight of Friday of week 11
Position Control Experiment†	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 midnight of Friday Week 11	11.59 pm of Tuesday of Week 12	By midnight of Friday of week 13
Final exam	2 hours	50%	1,2,3 and 4	All course content from weeks 1-12	Exam period, date TBC	N/A	Upon release of final results

† The laboratory experiment specifications will be available from week 2 onwards in Moodle.

Assignments

Presentation

During experimentations, each student will collect his/her own personalized data. It is essential that each student use his/her personalized data in his/her reports. Marks are awarded for neat, tidy and complete reports with complete content as specified in the laboratory instructions sheets. Your content will not be marked if the reports are not presented with the presentation quality specified in the laboratory instructions sheets.

Submission

Late submissions will be penalised 5 marks per calendar day (including weekends). An extension may only be granted in exceptional circumstances. Special consideration for assessment tasks must be processed through student.unsw.edu.au/special-consideration.

It is always worth submitting late assessment tasks when possible. Completion of the work, even late, may be taken into account in cases of special consideration.

Where there is no special consideration granted, the 'deadline for absolute fail' in the table above indicates the time after which a submitted assignment will not be marked, and will achieve a score of zero for the purpose of determining overall grade in the course.

Assessment Criteria

Please refer to the Assignment Specification sheets.

Examinations

You must be available for all tests and examinations. Final examinations for each course are held during the University examination periods, which are June for Semester 1 and November for Semester 2.

Provisional Examination timetables are generally published on myUNSW in May for Semester 1 and September for Semester 2.

For further information on exams, please see the Exams section on the intranet.

Calculators

You will need to provide your own calculator, of a make and model approved by UNSW, for the examinations. The list of approved calculators is shown at https://student.unsw.edu.au/exam-approved-calculators-and-computers

It is your responsibility to ensure that your calculator is of an approved make and model, and to obtain an "Approved" sticker for it from the School Office or the Engineering Student Centre prior to the examination. Calculators not bearing an "Approved" sticker will not be allowed into the examination room.

Special Consideration and Supplementary Assessment

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

7. Attendance

You are required to attend a minimum of 80% of all classes, including lectures, labs and seminars. It is possible to fail the course if your total absences equal to more than 20% of the required attendance. Please see the School intranet and the UNSW attendance page for more information.

8. 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

9. 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.

10. 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: 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

Further information on School policy and procedures in the event of plagiarism is available on the intranet.

11. Administrative matters and links

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

- Attendance, Participation and Class Etiquette
- UNSW Email Address
- Computing Facilities
- Assessment Matters (including guidelines for assignments, exams and special consideration)
- Academic Honesty and Plagiarism
- Student Equity and Disabilities Unit
- Health and Safety
- Student Support 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