Course Outline

Semester 2 2015

Never Stand Still | Engineering | Mechanical and Manufacturing Engineering

MTRN3020

MODELLING AND CONTROL OF MECHATRONIC SYSTEMS

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1. Staff Contact Details

Contact details and consultation times for course convenor

Name: Associate Professor Jay Katupitiya
Office: ME311F
Tel: (02) 9385 4096
Email: J.Katupitiya@unsw.edu.au

Consultation Times: In session Tuesdays from 5-6 pm.

2. Course details

Credit Points:

This is a 6 unit-of-credit (UoC) course, and involves three 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

Lectures	Day	Time	Location
	Thursday	12 noon – 2 pm	Colombo Theatre C
Demonstrations	Monday	9 am – 10 am	Ainsworth Building 203
	Monday	9 am – 10 am	Ainsworth Building 204
Laboratories†			
	Monday	3 pm – 6 pm	MTRN212 (Willis Annex)
	Tuesday	9 am – 12 noon	MTRN212 (Willis Annex)
	Wednesday	9 am – 12 noon	MTRN212 (Willis Annex)
	Wednesday	12 noon – 3 pm	MTRN212 (Willis Annex)
	Friday	9 am – 12 noon	MTRN212 (Willis Annex)
	Friday	1 pm – 4 pm	MTRN212 (Willis Annex)

† These will be held in weeks 4, 6 and 8 only

Summary of the Course

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

Aims of the Course

Description: 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 up on 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 corner stone of the fundamental courses on which the Mechatronic Engineering course at UNSW is built up on. 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 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

3. Teaching strategies

Teaching of this course is through lectures and laboratory sessions. All laboratory work is individual work and attendance is preferred.

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 all the guidance and assistance is managing the laboratory tasks.

4. Course schedule

Topic	**Thursdays (1200-1400)**	**Location**	**Lecture Content**	**Demo/ Lab**	**Suggested Readings**
Introduction	Week 1	Colombo C	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
Automatic Control Systems	Week 2	Colombo C	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 C	z-transforms, Inversion Techniques, Pulse Transfer functions.	None	Moodle lecture notes
Computer Controlled Systems	Week 4	Colombo C	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 C	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 C	Root Locus Method, Direct Design Method	None	Moodle lecture notes
Design Methods for Discrete Time Controllers	Week 7	Colombo C	Indirect Design Method, State Space Method	None	Moodle lecture notes
Design Methods for Discrete Time Controllers	Week 8	Colombo C	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 C	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 C	Determining observability and controllability of a system	None	Moodle lecture notes
Estimators	Week 11	Colombo C	Predictive and current observer design	None	Moodle lecture notes
Revision	Week 12	Colombo C	Revision	None	Moodle lecture notes

5. Assessment

Assessment task	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date, time, and submission requirements
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
Speed Control Experiment†	A full report as per submission specifications.	15%	3 - 4	Refer to laboratory specification for exact details.	Submit electronically to Moodle submission site by midnight of Friday Week 9
Position Control Experiment†		20%	3 - 4	Refer to laboratory specification for exact details.	Submit electronically to Moodle submission site by midnight of Friday Week 11
Final exam	2 hours	50%	1- 4	All course content from weeks 1-12	Exam period, date TBC

† 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. Where an assessment task is worth less than 20% of the total course mark and you have a compelling reason for being unable to submit your work on time, you must seek approval for an extension from the course convener ***before the due date***. Special consideration for assessment tasks of 20% or greater must be processed through https://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.

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 Administrative Matters.

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 Administrative Matters, available on the School website and on Moodle, and the information on UNSW’s Special Consideration page.

6. 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.

Library:
http://info.library.unsw.edu.au/web/services/services.html

7. Course evaluation and development

Feedback on the course is gathered periodically using various means, including the Course and Teaching Evaluation and Improvement (CATEI) 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 lecturer’s feedback to those students who choose to submit their solutions to computer lab exercises before the worked solutions are released. No marks will be awarded for these submissions.

8. 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: https://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:
http://www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Further information on School policy and procedures in the event of plagiarism is presented in a School handout, Administrative Matters, available on the School website.

9. Administrative Matters

You are expected to have read and be familiar with *Administrative Matters*, available on the School website: www.engineering.unsw.edu.au/mechanical-engineering/sites/mech/files/u41/S2-2015-Administrative-Matters_20150721.pdf

This document contains important information on student responsibilities and support, including special consideration, assessment, health and safety, and student equity and diversity.

Jay Katupitiya
20 July 2015

Appendix A: Engineers Australia (EA) Professional Engineer Competency Standards

	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