ELEC466

Advanced Mechatronic Engineering

S1 Day 2017

Dept of Engineering

Contents

General Information

Unit convenor and teaching staff
Unit Convenor
David Inglis
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E6B-122
Mondays 4-5pm, Thursday 9-10am

Lecturer
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E6B-112
Wednesdays 2-4 pm

Credit points
3

Prerequisites
(60cp at 100 level or above) including (ELEC326 and ELEC324)

Corequisites

Co-badged status

Unit description
This unit integrates prior learning in a specialist area of engineering with problem solving, emerging technology and aspects of engineering application, technical reporting and self-management to prepare students to work at a professional capacity. The unit aims to address the application of fundamental principles and methods at an advanced level in the context of standards and practices, modelling, analysis, design and practical implementation. The unit also develops skills in the critical evaluation of information, software and sources of error, and experimental methods. Learning will be achieved using case studies, laboratories, presentations, group work and/or traditional lecture format. The specific topics will focus on current advances in the area such as microcontrollers, MEMs, nanotechnologies, control systems, sensors and actuators and electro-mechanical interfacing.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

Mathematically model real-world, closed and open loop, digital motion control systems

Design, implement and test a controller for a digital motion control system

Demonstrate, creativity, problem solving, initiative and time management skills in the completion of a significant project

Solve forward and inverse kinematic transformations for multi-link robotic systems

Demonstrate knowledge of the manufacturing processes and operational physics of MEMS

General Assessment Information

To obtain a passing grade (P/CR/D/HD) a total mark of 50 more is required AND a mark of 50 or more is required for the final examination. The final exam is a hurdle requirement because it is the only reliable assessment of individual performance for this unit. A passing grade of 50% or more in the final examination is a condition of passing this unit. Students who make a serious attempt but fail to meet the hurdle requirement will be given one further opportunity to pass. A serious attempt is defined as achievement of a mark of 40% or greater.

Assessment Tasks

Name	Weighting	Hurdle	Due
Report 1 – System Parameters	6%	No	Week 2
Homework / Problem sets	24%	No	See individual tasks
Report 2 – Circuit diagram	6%	No	Week 3
Report 3 – System model	6%	No	Week 5
Report 4 – System Performance	6%	No	Week 7
Project Demonstration	6%	No	Week 11
Report 6 - Complete Report	6%	No	week 11
Project Logbook	10%	No	Week 11 Prac
Final Exam	30%	Yes	exam period

Report 1 – System Parameters

Due: **Week 2**

Weighting: **6%**

You will be building a project report throughout the first 11 weeks of this unit. By week 11 each of you will have produced a report that includes the following headings: Introduction, System parameters, System Model, Electrical Specifications, System Performance. The total report length must not exceed 5 pages. Use 2 cm margins and Arial 10 pt font. Any additional pages will incur a 20/100 mark reduction.

Your task is to model and develop a digital servo controller with an adaptive gain for an arm of known mass. You will be given a motor, gearbox, encoder, arm, load, Arduino, motor driver, and power supply.

The first step is to measure your system parameters and begin to write your report. Write a very brief introduction and the system parameters section. Important system parameters include:

- Mass and dimensions of any moving components.
- Current and voltage limitations of supplies, sources, drivers etc.
- Friction torques
- DC motor characteristics: torque constant, speed constant, terminal resistance, stall torque, no load speed, gear reduction, etc.…
- Mechanical layout (a simple diagram in your report is a good idea)

Your first assessment task is to start your report It will be graded as follows for a maximum of 15 marks.

0-5 marks: presentation and report structure. Use a consistent style. Proof-read your document for grammatical and typographical mistakes. Use accurate and concise language. Examples of inaccurate language include: “An elephant went to the store to buy milk. It was awesome” What was awesome, the milk or the trip? “Last night I shot an elephant in my pajamas.” Who was wearing the pajamas, you or the elephant?

0-10 marks: Accurate description of all relevant system parameters

On successful completion you will be able to:

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Homework / Problem sets

Due: **See individual tasks**
Weighting: **24%**

4 problem sets, each worth 6%. Questions and rubric to be posted with questions.

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Report 2 – Circuit diagram

Due: **Week 3**
Weighting: **6%**

Complete section 3, the electrical specifications section of your report. This should primarily consist of a complete circuit diagram, and any accompanying notes that you think are necessary. Submit your report, which should include revisions to prior sections.

0-5 marks: presentation and report structure. Use a consistent style. Proof-read your document for grammatical and typographical mistakes. Use accurate and concise language.

0-10 marks: Acceptable circuit diagram with clearly labelled components.

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Report 3 – System model

Due: **Week 5**
Weighting: **6%**

Complete section 2, system model. In this section you must derive the equation of motion for your system. Describe assumptions and expected limitations of the model. A limitation is something that your model is ignoring, for example, electrical inductance. Pay careful attention to how friction affects the system motion.

0-5 marks: presentation and report structure. Use a consistent style. Proof-read your document for grammatical and typographical mistakes. Use accurate and concise language.

0-10 marks: Clear, accurate, and concise treatment of the electromechanical system

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Report 4 – System Performance

Due: **Week 7**
Weighting: **6%**

Begin work on system performance section. Model system performance using a numerical method in matlab. There is no need to use any complicated functions. Start from an initial position with speed of 0, then step forward in time, using your equation of motion to predict each new position and speed. Create polar plots of overshoot, steady state error and settling time for 15 and 45 degree moves. You do not need a data point at every degree, every 10 degrees is OK. This should be three plots, each with 2 curves on them. Keep them compact and use large fonts.

0-5 marks: presentation and report structure. Use a consistent style. Proof-read your document for grammatical and typographical mistakes. Use accurate and concise language.

0-10 marks: Well-presented numerical model with clear plots and performance indicators.

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Project Demonstration

Due: **Week 11**
Weighting: **6%**

Your system will be graded in week 11. Each system (for a group of 2) will receive 1 grade. Log books for that group will be used to create individual grades for the demonstration where the average of the individual grades will equal the group grade

. Draft assessment criteria: D for a system with less than 1 degree of overshoot, for any step change up to 90 degrees, less than 1 degree of SSE, and less than 3 second response time. Cr for 1-2 degrees overshoot or SSE. An unstable system or anything with more than 5 degrees SSE or overshoot, or exceedingly long (>10s) settling time is considered a fail. This is the first time this has been run, so these criteria may be changed.

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Report 6 - Complete Report

Due: **week 11**
Weighting: **6%**

Complete your report by adding measured data to your system response plots. Compare the measured data to the model predictions. Be sure the model data reflects system parameters described earlier in the report. Include descriptions of how the measurements were made and what their significance is.

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Project Logbook

Due: **Week 11 Prac**
Weighting: **10%**

Whenever working on your major project you should use an individual log book to document your progress. This may be a bound paper document or an electronic log. In grading you log book, we will be looking for dates and times of work done, as well as evidence of quality work, especially the application of science or engineering practice. This is your chance to show the good work you have done on the group project. Include sketches, diagrams, calculations, data etc. A table of contents, which is completed as you go, and points to significant or useful pages can also be useful. (One third of marks for evidence of work and attendance in pracs; one third for legibility, traceability and organisation; one third for evidence of Technical content including sketches, calculations etc.

Your log book will be used to determine an individual grade for the Project Demonstration.

On successful completion you will be able to:

- Design, implement and test a controller for a digital motion control system
- Demonstrate, creativity, problem solving, initiative and time management skills in the completion of a significant project

Final Exam

Due: **exam period**
Weighting: **30%**
This is a hurdle assessment task (see assessment policy for more information on hurdle

assessment tasks)

The final exam will cover topics dealt with in lectures and on assignments. You are permitted one A4 sheet of hand-written notes.

On successful completion you will be able to:

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- Demonstrate knowledge of the manufacturing processes and operational physics of MEMS

Delivery and Resources

Delivery: Attendance in lectures is strongly recommended. Audio or video recordings of the lecture may not be available.

Textbook Resources: Selected topics from:

A. Smaili and F. Mrad, “Mechatronics, Integrated Technologies for Intelligent Machines”, Oxford University Press, 2008.

Nanua Singh, “Systems Approach to Computer-integrated Design and Manufacturing”

John J. Craig, “Introduction to Robotics”

Serope Kalpakjian, “Manufacturing Engineering and Technology”

Additional recommended readings may be assigned and provided in iLearn.

Technology and Software: We will make use of MATLAB for modelling and Arduino for embedded system programming. We recommend Fritzing for combuter-based arduino modelling. You will have access to computers with this software during prac, however access to these programs outside of prac will be beneficial.

Late Submissions: Unless agreed to in advance of due dates, late submissions will not be allowed.

Extensions: Extensions may be granted if a valid case for disruption to studies exits. See policies and procedures below.

Unit Schedule

A unit schedule will be available on iLearn.

Learning and Teaching Activities

Project

Students will conduct practical work in pairs, but will submit individual reports.

Assignments

Students will complete assignments/homework to practice and consolidate learning

Log Book

Students must keep a log book demonstrating their work on the project

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central. Students should be aware of the following policies in particular with regard to Learning and Teaching:

Academic Honesty Policy http://mq.edu.au/policy/docs/academic_honesty/policy.html

Assessment Policy http://mq.edu.au/policy/docs/assessment/policy_2016.html

Grade Appeal Policy http://mq.edu.au/policy/docs/gradeappeal/policy.html

Complaint Management Procedure for Students and Members of the Public http://www.mq.edu.au/policy/docs/complaint_management/procedure.html

Disruption to Studies Policy (in effect until Dec 4th, 2017): http://www.mq.edu.au/policy/docs/disruption_studies/policy.html

Special Consideration Policy (in effect from Dec 4th, 2017): https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policies/special-consideration

In addition, a number of other policies can be found in the Learning and Teaching Category of Policy Central.

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/support/student_conduct/

Results

Results shown in *iLearn*, or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au.

No extensions will be granted. Late tasks will be accepted up to 72* hours after the submission deadline. There will be a deduction of 20%* of the total available marks made from the total awarded mark for each 24 hour period or part thereof that the submission is late (for example, 25 hours late in submission – 40% penalty). This penalty does not apply for cases in which an application for special consideration is made and approved.

Student Support

Macquarie University provides a range of support services for students. For details, visit http://stu

dents.mq.edu.au/support/

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

Student Services and Support

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.

Graduate Capabilities

Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

Assessment task

- Project Logbook

Learning and teaching activity

- Students will conduct practical work in pairs, but will submit individual reports.
- Students must keep a log book demonstrating their work on the project

Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement.

They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

Learning outcome

- Demonstrate, creativity, problem solving, initiative and time management skills in the completion of a significant project

Assessment tasks

- Project Demonstration
- Project Logbook

Learning and teaching activities

- Students will conduct practical work in pairs, but will submit individual reports.

Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Assessment tasks

- Homework / Problem sets
- Project Demonstration
- Report 6 - Complete Report
- Final Exam

Learning and teaching activities

- Students will conduct practical work in pairs, but will submit individual reports.

Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcomes

- Mathematically model real-world, closed and open loop, digital motion control systems
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- Demonstrate knowledge of the manufacturing processes and operational physics of MEMS

Assessment tasks

- Report 1 – System Parameters
- Homework / Problem sets
- Report 2 – Circuit diagram
- Report 3 – System model
- Report 4 – System Performance
- Project Demonstration
- Report 6 - Complete Report
- Final Exam

Learning and teaching activities

- Students will conduct practical work in pairs, but will submit individual reports.
- Students will complete assignments/homework to practice and consolidate learning
- Students must keep a log book demonstrating their work on the project

Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- Mathematically model real-world, closed and open loop, digital motion control systems
- Solve forward and inverse kinematic transformations for multi-link robotic systems
- Demonstrate knowledge of the manufacturing processes and operational physics of MEMS

Assessment tasks

- Report 1 – System Parameters

- Report 3 – System model
- Report 4 – System Performance
- Project Demonstration
- Report 6 - Complete Report
- Project Logbook
- Final Exam

Learning and teaching activities

- Students will conduct practical work in pairs, but will submit individual reports.
- Students will complete assignments/homework to practice and consolidate learning

Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Assessment tasks

- Project Logbook
- Final Exam

Learning and teaching activities

- Students will conduct practical work in pairs, but will submit individual reports.
- Students will complete assignments/homework to practice and consolidate learning
- Students must keep a log book demonstrating their work on the project

Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

Learning outcomes

- Mathematically model real-world, closed and open loop, digital motion control systems
- Demonstrate, creativity, problem solving, initiative and time management skills in the completion of a significant project

Assessment tasks

- Report 1 – System Parameters
- Homework / Problem sets
- Report 2 – Circuit diagram
- Report 3 – System model
- Report 4 – System Performance
- Report 6 - Complete Report

Learning and teaching activities

- Students will conduct practical work in pairs, but will submit individual reports.

Engaged and Ethical Local and Global citizens

As local citizens our graduates will be aware of indigenous perspectives and of the nation's historical context. They will be engaged with the challenges of contemporary society and with knowledge and ideas. We want our graduates to have respect for diversity, to be open-minded, sensitive to others and inclusive, and to be open to other cultures and perspectives: they should have a level of cultural literacy. Our graduates should be aware of disadvantage and social justice, and be willing to participate to help create a wiser and better society.

This graduate capability is supported by:

Learning and teaching activities

- Students will complete assignments/homework to practice and consolidate learning

Changes from Previous Offering

There are no significant structural changes to this unit from last year, however the content of some lectures will be different, and the final exam will reflect current topics.

Changes since First Published

Date	Description
03/03/2017	David Inglis' Monday Consultation hours changed to 4-5pm.