# ELEC326

## Mechatronic Systems

S2 Day 2014

*Dept of Engineering*

## Contents




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# General Information

Unit convenor and teaching staff
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Credit points
3

Prerequisites
39cp including (ELEC324(P) and ELEC260 (P))

Corequisites

Co-badged status

Unit description
This unit is on the theory and practice of designing mechatronic systems. This unit covers system modelling, theory and application of fundamental and advanced control algorithms, decision-making techniques, implementation (including the use of digital microcontrollers), validation and testing. Advanced topics in the unit cover robust and adaptive control methods, for nonlinear and time-varying systems.

## 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:

1. Demonstrate understanding of mechatronic systems and building blocks of them
2. Learn the systematic design process for creating new mechatronic machines;
3.. Apply pneumatic, and PLCs integrated with pneumatics to control mechatronic systems;
4. Create and modify integrated pneumatic and PLC circuits;
5. Understanding of intelligent control / hierarchical control machines.

# General Assessment Information

Note that all assessments are mandatory.

**Major Project:**

As the students gradually learn, in this unit, the theories of designing mechatronic machines and components/units required for building mechatronic machines, they are suppose to practice their growing knowledge in practice by accomplishing a team based project over the semester. Students in small teams (3-4 persons in a group) select a project topic at the very beginning of the semester. Groups of students are supposed to produce design projects using a systematic method. Detail of a systematic design method is provided in lecture classes over the semester.

**Important dates:**

Week 1-2: Team building and project topic selection;

Week 6-7: Mid-semester project progress submission and review;

Week 13: Project presentation in the class using PowerPoint documents;

Week 14: Submission of printed hard copy of written reports.

**Assessment components of the project works are as follows:**

| | |
|---|---|
| System design project technical report (Mid-semester) – peer reviewed & improved | 10% |
| System design project technical report & presentation (Semester-ending) | 25% |
| System design project logbook (individual submission) | 5% |

**Project Report Presentation:**

Teams are supposed to present their major achievements of mechatronics design projects in groups using a prepared PowerPoint document in Week 13 during the 3-hour practical session. Total duration for presentation for each group is 20mins including question time. Equal contribution of each member is essential. Assessment of design project quality and presentation is to be performed by a panel.

**Design Project Report**:

You are to prepare a detail technical report on your design project group-wise. It should cover the topics in depth, detailing the options and technology choices in the area. It should conclude with a well justified implementation plan/decision.

The report may include sections like statement of primary need, design problem solution technique with applications of actuators, sensors, control system, and conceptual design, layout design, physical control systems for intelligence, assembly drawing, detail drawings of selected parts, project specification and design economics.

You must submit a .doc to iLearn and a printed hard copy by the due date for assessment.

**Due:** Week 13 during the project presentation.

**Laboratory Experiments (Worth 20%)**:

Each student must perform six laboratory experiments during the semester. Each laboratory session duration is at least two hours. Laboratory experiments are designed to develop practical knowledge of the theoretical aspects of the subject matters. They are devoted to physical understanding of pneumatic control systems and applications and PLCs programming applicable for mechatronics machine development.

A fresh original report must be submitted on each experiment performed in TWO WEEKS time after the experiment been accomplished. The report should be written according to the following standard layout:

- A title page
- Number and name of experiment
- Objective/s (of the experiment)
- Theoretical background
- Equipment and tools used
- Sketch of the experimental set-up and relevant circuit
- Method / procedure
- Result
- Conclusion

*Assessment* on laboratory works is marked in the following two sections equally:

- Individual performance during the laboratory sessions, and
- Quality of the report submitted.

**Final Exam (40% of total marks)**:

The final exam will cover topics dealt with in lectures and tutorial classes. The exam duration will be 2 hours, and it will be worth 40% of your final grade.

# Assessment Tasks

| Name | Weighting | Due |
|---|---|---|
| Major Project | 40% | Wk 6 & Wk 13 |
| Practical | 20% | Wks 4 - 13 |
| Final exam | 40% | Exam Timetable |

## Major Project

Due: **Wk 6 & Wk 13**

Weighting: **40%**

Group based project on Mechatronic System design spread over the 13 weeks of study:

On successful completion you will be able to:

- 1. Demonstrate understanding of mechatronic systems and building blocks of them
- 2. Learn the systematic design process for creating new mechatronic machines;
- 4. Create and modify integrated pneumatic and PLC circuits;
- 5. Understanding of intelligent control / hierarchical control machines.

## Practical

Due: **Wks 4 - 13**
Weighting: **20%**

Laboratory experiments on pneumatic control used for mechatronic machines. Some of the experiments may involve pneumatics integrating with PLCs.

On successful completion you will be able to:

- 2. Learn the systematic design process for creating new mechatronic machines;
- 3.. Apply pneumatic, and PLCs integrated with pneumatics to control mechatronic systems;
- 4. Create and modify integrated pneumatic and PLC circuits;

## Final exam

Due: **Exam Timetable**
Weighting: **40%**

Final examination will cover materials of lecture and practical classes.

On successful completion you will be able to:

- 2. Learn the systematic design process for creating new mechatronic machines;
- 4. Create and modify integrated pneumatic and PLC circuits;
- 5. Understanding of intelligent control / hierarchical control machines.

# Delivery and Resources

Teaching and learning materials will be available on the course iLearn website organised on weekly basis. **Unit homepage:** https://ilearn.mq.edu.au/login/MQ/

**On-campus** lecture and practical sessions are as follows:

Lectures: L1 on Mon 2-3pm, E5A-140;

L2 on Tue 12-1pm, W5C-211;

Lab. & Tut. Sessions: Thurs 2-5pm, F9C-145.

Note: Please see the detailed delivery schedule in the Unit schedule section.

**Literature used are as follows:**

**Text Books:** (Not adopted)

**References** (Any edition of the followings may be adequate. Students may achieve some access electronically):

1. D. Shetty, R. A. Kolk - Mechatronics system design, PWS Publishing, Boston, 1997.
2. D. Bradely, et el. – Mechatronics and the design of intelligent machines and systems. Stanely Thornes Ltd., UK, 2000.
3. ROHNER Peter – Industrial Hydraulic Control. JW & Sons. 1989.
4. K. T.Ulrich, S. D. Eppinger Product design and development. McGraw Hill ,NY, 1995.
5. IEEE Transactions on Robotics and Automation (selected articles from different numbers).

# Unit Schedule

| WEEK/ DATE | TOPICS (2 hrs) | Text & submission due | LEARNING OUTCOMES |
|---|---|---|---|
| Wk 1 L1 & L2 | Mechatronic systems - Introduction; Units of mechatronic systems: Actuators, sensors, control, mechanism; | 1 & 2; Select project title | Understand mechatronic machines |
| Wk 2 | Systematic design of Mechatronics Systems; Primary needs; Systematic method for design problem solution; | 4; Finalise project selection | Create a new machine Learn conceptual design |
| Wk 3 | Design problem analysis & synthesis; Conceptual mechatronics design; Secondary needs; | 4 | Learn the systematic design process of a new machine |
| Wk 4 | Rating & Scoring ; Iterative design; lateral thinking; design life cycle; Concurrent engineering in mechatronics; | 4 | Make improvement of design and redesign |
| Wk 5 | Pneumatic logic components; Signal flow and circuit layout; Actuators: linear and rotary, rod-less. Cylinder; performance characteristics; | 3 | Select logic components and actuators for design |

| | | | |
|---|---|---|---|
| Wk 6 | Directional control valves (DCVs): design details and working principles; Symbols and standards; | 3;<br>Mid-semester project review | Select DCVs for circuit for controlling a machine |
| Wk 7 | Pneumatic control circuit design;<br>Logic functions AND, OR; | 3;<br>Mid-semester project review | Apply AND, OR functions in circuit |
| Wk 8 | Signal elements, flow control, process control, quick exhaust, proximities;<br>System life cycle; | 3 | Select auxiliary pneumatic valves for design |
| Wk 9 | PLC architecture and programming technique; | 1 & 2 | Understand architect. design of PLCs and apply PLCs in control |
| Wk 10 | Electro-pneumatic circuit design;<br>Machine control using pneumatics and PLCs;<br>Vacuum technology, venturi, suction cups; | 1, 2, 5 | Apply PLCs in integration with pneumatics |
| Wk 11 | Controlling two cylinders;<br>Controlling multiple actuators – coordinated motion; | 3 | Create and modify integrated pneumatic and PLC circuits |
| Wk 12 | Mechanisms for mechatronic machines; | 1 | Apply mechanical units in mechatronic machines |
| Wk 13 | Intelligence of mechatronic systems: ANN, FLC;<br>Modelling of mechatronic systems; | 5;<br>Project presentation | Grow intelligence in mechatronic machines |
| wk 14 | Course enhancement | Project report submission | |

# 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.html

Grading Policy http://mq.edu.au/policy/docs/grading/policy.html

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

Grievance Management Policy http://mq.edu.au/policy/docs/grievance_management/policy.html

Disruption to Studies Policy http://www.mq.edu.au/policy/docs/disruption_studies/policy.html *The Disruption to Studies Policy is effective from March 3 2014 and replaces the Special Consideration Policy.*

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/

## Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.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://informatics.mq.edu.au/help/.

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

# Graduate Capabilities

## 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

- 1. Demonstrate understanding of mechatronic systems and building blocks of them

## 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:

### Learning outcomes

- 1. Demonstrate understanding of mechatronic systems and building blocks of them
- 4. Create and modify integrated pneumatic and PLC circuits;
- 5. Understanding of intelligent control / hierarchical control machines.

### Assessment tasks

- Major Project
- Practical

## 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

- 1. Demonstrate understanding of mechatronic systems and building blocks of them
- 3.. Apply pneumatic, and PLCs integrated with pneumatics to control mechatronic systems;
- 4. Create and modify integrated pneumatic and PLC circuits;
- 5. Understanding of intelligent control / hierarchical control machines.

## Assessment tasks

- Major Project
- Practical
- Final exam

# 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

- 1. Demonstrate understanding of mechatronic systems and building blocks of them
- 2. Learn the systematic design process for creating new mechatronic machines;
- 3.. Apply pneumatic, and PLCs integrated with pneumatics to control mechatronic systems;

## Assessment tasks

- Major Project
- Practical
- Final exam

# 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:

## Learning outcomes

- 1. Demonstrate understanding of mechatronic systems and building blocks of them
- 3.. Apply pneumatic, and PLCs integrated with pneumatics to control mechatronic systems;
- 5. Understanding of intelligent control / hierarchical control machines.

## Assessment tasks

- Major Project
- Practical
- Final exam

# 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:

## Learning outcomes

- 1. Demonstrate understanding of mechatronic systems and building blocks of them
- 2. Learn the systematic design process for creating new mechatronic machines;
- 4. Create and modify integrated pneumatic and PLC circuits;
- 5. Understanding of intelligent control / hierarchical control machines.

## Assessment tasks

- Major Project
- Practical
- Final exam

# 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

- 1. Demonstrate understanding of mechatronic systems and building blocks of them
- 2. Learn the systematic design process for creating new mechatronic machines;
- 4. Create and modify integrated pneumatic and PLC circuits;

## Assessment tasks

- Major Project
- Practical

## 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 outcome

- 2. Learn the systematic design process for creating new mechatronic machines;

### Assessment tasks

- Major Project
- Practical

## Socially and Environmentally Active and Responsible

We want our graduates to be aware of and have respect for self and others; to be able to work with others as a leader and a team player; to have a sense of connectedness with others and country; and to have a sense of mutual obligation. Our graduates should be informed and active participants in moving society towards sustainability.

This graduate capability is supported by:

### Learning outcome

- 2. Learn the systematic design process for creating new mechatronic machines;

# Changes from Previous Offering

This is the first offering of this unit in its current form. Content may be upgraded during the course.

# Changes since First Published

| Date | Description |
| --- | --- |
| 08/08/2014 | Sorry Mike, Testing this out again. There are no changes here. David |