THE UNIVERSITY OF WESTERN AUSTRALIA

Unit Outline

School of Mechanical Engineering

www.mech.uwa.edu.au

Mechatronics Systems

MCTX2420

Credit points: 6

Semester 2

Crawley Campus

Unit Coordinator:

Dr Adam Wittek

adwit@mech.uwa.edu.au

Unit website:

http://www.mech.uwa.edu.au/mechatronics/MS

Contents

UNIT DESCRIPTION

Introduction

Mechatronics is not the same as robotics (read document "What is Mechatronics Engineering?"): it is a much broader discipline. We will look at case studies to explain this. Readily available case studies include the following:

- University energy management system and chilled water distribution network
- Computer disc drives
- ABB 1400 industrial robot (Mechatronics Laboratory G21)
- NUWAR parallel manipulator
- Sheep shearing robot (Mechatronics Laboratory G21)

Unit content

You will learn to solve problems that cross discipline boundaries between mechanical and electrical engineering and between engineering and computer science. At the same time you will also learn how mechatronics engineers represent the world that they work in. Specific topics include systems' representation using Functional Block Diagrams and Finite State Machines as well as examples of discrete and continuous systems and their control.

Learning outcomes

On completion of this unit, you should be able to:

- Apply the fundamentals of mechanics, thermodynamics and electrical engineering and practical numerical techniques to simulate mechatronics systems
- Apply finite state machine design methods to mechatronics systems
- Apply computer control systems and software implementation techniques to control simple discrete and continuous mechatronics systems
- Understand important design issues in actuators and sensors: the choice between continuous and discrete signals
- Justify the design choices in systematic and logical way, and communicate it in writing

Educational Principles

In this unit, you will be encouraged and facilitated to develop the ability to:

- Self-learning
- Team work
  (The projects in this unit are conducted in teams, and your performance as a team member is part of the assessment)
- Making independent design decisions and being accountable for these decisions
- Keeping systematic documentation of own work

CONTACT DETAILS

Unit contact

Unit coordinator

name:	Adam Wittek
email:	adwit@mech.uwa.edu.au
phone:	(08) 6488 7362
fax:	(08) 6488 1024
consultation hours:	Monday 3 pm – 4 pm
lecture times:	Monday 9 am
lecture building & room:	MATH:BLAKERS

Finite State Machine Lecturer

name:	Lyndon While
email:	lyndon@csse.uwa.edu.au
phone:	(08) 6488 2720
fax:	(08) 6488 1089
consultation hours:	Tuesday 10-11 am
lecture times:	Monday 9 am (weeks 3, 4, 5)
lecture building & room:	MATH:BLAKERS

Tutors

names:	Adam Wittek, Lyndon While (weeks 3 and 4)
tutorial times:	Monday 2 pm, Tuesday 10 am
tutorial building & room:	Monday ENCM: 261, Tuesday ENCM: 105

LabVIEW Instructors

names:	Adam Wittek, Bhavin Desai (National Instruments)
LabVIEW Instruction Laboratory times:	Thursday 9 am (only first four weeks of the semester)
laboratory building & room:	ENCM: G23

TEACHING AND LEARNING RESPONSIBILITIES

Teaching and learning strategies

The most useful techniques that help to build successful mechatronics systems are not mentioned in the textbooks. Consequently, there is no textbook for this unit and emphasis is on self-learning. You will learn the techniques that help to build mechatronics systems mostly through the project work, by conducting the assignments/laboratory exercises, and through mandatory reading of the selected journal articles. Lectures, tutorials and LabVIEW instruction classes are designed to provide the background for assignments and laboratory exercises. Therefore attending the lectures, tutorials and LabVIEW instruction classes is highly recommended.

Conducting the project is your own responsibility. The project supervisor/supervisors duty is to assist you and provide mentorship, but the supervisors cannot and will not do the project for you.

There are no formal pre-requisites to this unit. However, the learning in this unit is strongly based on the prior knowledge. In particular, the first year units **Engineering Dynamics**, **Introduction to Electrical and Electronic Engineering**, **Introduction to Professional Engineering**, **MATH1010: Calculus and Linear Algebra** and **MATH1020: Calculus, Statistics and Probability** contain highly recommended material for this course.

Other important contributing units are:

- **Engineering Design and Visual Communication**: Introduction to visual communication: learning to use eyes to notice and record detail, basic elements of mechanical design.
- **Manufacturing**: Introduction to basic elements of mechanical design and manufacturing.
- **Java Programming or C Programming**: Formal computer programming methods, object oriented programming, introduction to data structures and algorithms.
- **Engineering Mathematics**: Numerical methods for solving differential equations.

Charter of student rights

This Charter of Student Rights upholds the fundamental rights of students who undertake their education at the University of Western Australia.

It recognises that excellence in teaching and learning requires students to be active participants in their educational experience. It upholds the ethos that in addition to the University's role of awarding formal academic qualifications to students, the University must strive to instil in all students independent scholarly learning, critical judgement, academic integrity and ethical sensitivity.

Please refer to the following website for the full charter of student rights and responsibilities
http://handbooks.uwa.edu.au/undergraduate/poliproc/policies/StudentRights.

Student Guild contact details

The University of Western Australia Student Guild
35 Stirling Highway
Crawley WA 6009
Phone: (+61 8) 6488 2295
Facsimile: (+61 8) 6488 1041
E-mail: enquiries@guild.uwa.edu.au
Website: http://www.guild.uwa.edu.au

Use of student feedback

This unit is periodically evaluated through the Students Perception of Teaching (SPOT) surveys. You are also encouraged to provide more detailed feedback in the individual part of the project report.

Examples of how the feedback is incorporated into the unit include changes of the assessment scheme in 2008 (more marks were allocated for the project work and one of the exam questions was removed) and moving from weekly project progress reports in 2008 to fortnightly reports in 2009. Following the students' comments in the previous years, multi-threading was removed from the LabVIEW instruction classes in this year.

ASSESSMENT MECHANISM

Project Work

45% of assessment will be by the project participation and reporting. You have to build and/or design or modify working systems as part of this unit and success in doing so will be an important part of the assessment (see **The Guide to Project Work** for details). The project outcome does not have to be a complete system (which is too complex) but a sub-system (i.e. part of the larger system). The sub-system must integrate into a larger system.

The project list is available at http://wiki.mech.uwa.edu.au/index.php/Mechatronics:Visit_the_Mechatronics_Project_Wiki and through WebCT (Mechatronics Project page).

Note: Pay particular attention to the project activities in the first week of the semester. The Project Request Form (for details see The Guide to Project Work; http://www.mech.uwa.edu.au/mechatronics/MD/Projects/TheGuidetoMechatronicsProjects2009.pdf) is due by July 24 at 5 pm. If you are not included within a team project allocation submission, you officially belong to none of the project groups. Consequently, you will not be allowed to conduct the project and you will receive no mark for the project component of the course.

Examination

30% of the assessment will be by examination ("closed book") at the end of the semester.

You will be required to answer 3 questions:

1) A question on finite state machines,

2) A question on simulation, and

3) A question on an aspect of mechatronics systems, to be based on required reading component of the course.

Notice: No supplementary examinations will be available for the unit.

Assignments/Laboratory Exercises

24% of assessment will be for laboratory exercises/assignments:

- Finite state machines exercises 12%
  - Two exercises (each worth 6%)
- Simulation and/or on-line lab exercises 12%
  - Two exercises (each worth 6%)

Tutorial Activities

- A short (15 minutes) quiz (basic mechanical and electrical engineering) will be administered in the first week of the semester. The purpose of the quiz is to let us know what it is your prior knowledge of basic mechanical and electrical engineering. We will use this information when preparing the lectures and tutorials. You will be able to obtain up to 1.5% bonus mark (i.e. in addition to marks from the examination, projects and class exercises) for answering the quiz questions.
- A 10 minutes quiz (1% mark) will be administered in the beginning of Tutorial 2 (second week of the semester). The questions will cover self study (patent reading, study of automotive cruise control) required for this tutorial.
- Successful completion of Individual Study Simulation Module (multi-component model of electric iron) will attract up to 3.5% bonus mark.

Late Submission Penalties

Progress reports (including fortnightly reports) submitted late will be read but no marks will be awarded.

Late submissions of final project reports and assignments will be penalised: the marks will be reduced by 25% of the granted mark per week past due date.

Marks for demonstrations and project presentations that are deferred will be reduced by 25% per week past due week in comparison to the marks awarded for a similar demonstration in the due week.

Late submission penalties will only be waived in case of medical or personal emergencies reported to the Dean's office (copies of medical certificates etc. will be needed).

According to the university policy on special consideration, deferral of tests or exams or extensions of time for assignments on medical, personal or other grounds must be lodged with the faculty office no later than three working days after the due date for the assessment in question. This rule will apply to all students, except in exceptional circumstances.

Assessment mechanism summary

Item	Weight	Due Date
Project Work	45%	See table below
Assignment 1	6%	5 pm, Friday of Week 5
Assignment 2	6%	5 pm, Friday of Week 7
Assignment 3	6%	5 pm, Friday of Week 10
Assignment 4	6%	5 pm, Friday of Week 13
Tutorial exercises/activities (quiz in Tutorial 2)	1%	Week 2 (tutorial time)
Final exam	30%	
Quiz in Tutorial 1	Bonus: 1.5%	Week 1 (tutorial time)
Individual Study Simulation Module	Bonus: 3.5%	5 pm, Thursday of Week 11

Note: Always confirm the due dates with the unit timetable and assignment description. For details of assessment components of the Project Work see the table below.

Detailed project work assessment guide

Project request form Fortnightly reports	 10%	5 pm, Friday: Week 1 5 pm, Thursday: Week 3, Week 7, Week 8, Week 10
Scoping report (previously Interim progress report)	10%	5 pm, Thursday, Week 5
Project final report Total mark for the Final project report is 20%, made up from… • Main (group) report, including the initial specification, design process, testing, test results, final specification and documentation of finished design, and including final progress report, records of time spent etc. • Separately submitted, individual report on your contributions to the project, time spent, your experience, and what you learned from the project. (4 pages)	 15% 5%	5 pm, Thursday, Week 13
Project demonstration or presentation Made up from… • Demonstration of each function point specified. • Evidence of systematic design approach and testing of design/code related to the specified system functions • Answers to questions	5%	Week 12 (detailed schedule will be provided)
Total	45%	

Note: Confirm the due dates in this table with the unit timetable and The Project Guide

Unit marks may be **scaled** in line with the Faculty's Policy on Assessment Practices and Procedures: www.ecm.uwa.edu.au/studentnet/exams/assessment

Note that important information relating to policies, examinations, expectations, copyright, referencing, academic misconduct assistance with communication skills is available on the Faculty website though http://www.ecm.uwa.edu.au/studentnet/exams.

Ethical Scholarship, Academic Literacy and Academic Misconduct

[Ethical scholarship is the pursuit of scholarly enquiry marked by honesty and integrity.

Academic Literacy is the capacity to undertake study and research, and to communicate findings and knowledge, in a manner appropriate to the particular disciplinary conventions and scholarly standards expected at university level.

Academic misconduct is any activity or practice engaged in by a student that breaches explicit guidelines relating to the production of work for assessment, in a manner that compromises or defeats the purpose of that assessment. **Students must not engage in academic misconduct**. Any such activity undermines an ethos of ethical scholarship. Academic misconduct includes, but is not limited to cheating, or attempting to cheat, through:

- Collusion
- Inappropriate collaboration
- Plagiarism
- Misrepresenting or fabricating data or results or other assessable work
- Inappropriate electronic data sourcing/collection
- Breaching rules specified for the conduct of examinations in a way that may compromise or defeat the purposes of assessment.

Penalties for academic misconduct vary according to seriousness of the case, and may include the requirement to do further work or repeat work; deduction of marks; the award of zero marks for the assessment; failure of one or more units; suspension from a course of study; exclusion from the University, non-conferral of a degree, diploma or other award to which the student would otherwise have been entitled.

Refer to the Ethical Scholarship, Academic Literacy and Academic Misconduct (http://www.teachingandlearning.uwa.edu.au/tl4/for_uwa_staff/policies/student_related_policies/academic_conduct) and individual Faculty policies.

You may use previously published material in your reports and submissions, provided

a) you adhere to copyright restrictions, and

b) you provide the source references for all material that you did not prepare for the particular submission (e.g. diagrams, designs, software code, words or phrases quoted from other sources, whether written by yourself, other students, staff at UWA or people outside UWA)

c) you make it clear where you use the material that it is taken from another source document, and provide a reference (either direct citation or reference number) in the text or diagrams used.

Students have been severely penalised for failures to comply with these requirements in previous years.

Appeals against academic assessment

If students feel they have been unfairly assessed, they have the right to appeal their mark by submitting an Appeal Against Academic Assessment form to the Head of

School and Faculty Office. The form must be submitted within **twelve working days** of the formal despatch of your unit assessment. It is recommended that students contact the Guild Education Officers to aid them in the appeals process. They can be contacted on +61 8 6488 2295 or education@guild.uwa.edu.au. Full regulations governing appeals procedures are available in the University Handbook, available online at http://www.publishing.uwa.edu.au/handbooks/interfaculty/PFAAAA.html.

WebCT and Mechatronics Wiki: Unit and Mechatronics Project pages (most recent information about the unit)

Note: Please use the unit WebCT forum for communication. Direct Email communication may not be answered quickly. If you have a question which is not strictly a private matter, post it on the general forum so everyone can see the response. If you have a problem, check the forum to see if it has already been asked.

Unit Website

Unit website:
http://www.mech.uwa.edu.au/mechatronics/MS/

For detailed information about the Project Work see:
http://wiki.mech.uwa.edu.au/index.php/Mechatronics:Visit_the_Mechatronics_Project_Wiki

and

http://www.mech.uwa.edu.au/mechatronics/MD/Projects/Mechatronics Projects.html

For information about the Mechatronics course see:
http://www.mech.uwa.edu.au/mechatronics/

Note: Both the unit website and WebCT will provide access to the notes and class presentations. For most recent information about the unit access WebCT.

Mandatory Reading

- Notes and other reading materials provided by the lecturers (available via WebTC and unit website), including The Guide to Project Work

- Rosero, J. A., Ortega, J.A., Aldabas, E., Romeral, L. (2007) Moving towards a more electric aircraft. *IEEE Aerospace and Electronic Systems Magazine,* 22**,** pp. 3-9. (Available through Course Material On-line CMO library service http://www.library.uwa.edu.au/)
  Note: One examination question will be based on reading of the paper by Rosero et al. (2007)

Recommended Textbooks

- De Silva, C.W. (2005) *Mechatronics: An Integrated Approach*, CRC Press, Boca Raton. (Available in the Mechatronics Laboratory G19 and Mathematics & Physical Sciences Library)

- Johnson, G.W. and Jennigs, R. (2006) *LabVIEW Graphical Programming*, Fourth Edition, McGraw-Hill, New York. (Available in the Mechatronics Laboratory G19)

Other Books and Journals

- Trevelyan, J.P. (1992) *Robots for Shearing Sheep: Shear Magic*, Oxford University Press, Oxford. (This book describes the robotic shearing project and provides some useful background material on the way that mechatronics engineering is practiced. Available in Mathematics & Physical Sciences Library.)

- *IEEE Robotics and Automation Magazine* – available in Mathematics & Physical Sciences Library.

- *ASME Mechanical Engineering* – provides monthly "new products" section and many interesting articles relevant to mechatronics. Available in Mathematics & Physical Sciences Library (and at http://memagazine.asme.org/)

- *Industrial Robot Journal* - available in the Mechatronics Laboratory G.19 - tends to provide articles of practical and topical interest as well as formal refereed

- *Mechatronics* – formal refereed papers on mechatronics - the leading international journal in the field. Available in Mechatronics Laboratory G. 19.

- *Journal of Robotic Systems* - another leading journal with formal peer reviewed papers. Available in Mechatronics Laboratory G. 19.
- *Robotica* – robotics journal with good "news" section at the front, followed by peer reviewed papers. Available in Mechatronics Laboratory G. 19.
- *Computer* – a journal published by the IEEE Computer Society. It publishes highly acclaimed peer-reviewed articles written for and by professionals representing the full spectrum of computing technology from hardware to software and from current research to new applications. Providing more technical substance than trade magazines and more practical ideas than research journals. Available in Mathematics & Physical Sciences Library.

Borrowing and Using Reading Material Available in Mechatronics Laboratory (G.19)

Please note that any material in the Mechatronics Laboratory can be borrowed on an *overnight* basis only - you must write your name and telephone number in the loans book near the door.

Journals in the Mechatronics Laboratory are personal copies of the academics from the Mechatronics Discipline. Please respect this. Not all the journals in the laboratory are held in the UWA library.

Software Used

- LabVIEW (installed on computers in the School of Mechanical Engineering computer laboratories)

- Telelabs Login (installed on computers in the School of Mechanical Engineering computer laboratories)

- Microsoft Office (installed on computers in the School of Mechanical Engineering computer laboratories)

Note: Projects may require additional software.

UNIT STRUCTURE

Overview

Attendance of lectures, tutorials and LabVIEW instruction classes is not mandatory, but highly recommended as there is no textbook in this unit.

- Lectures
  - 1 hour per week; Monday 9 am in [MATH] BLAKERS;
- Tutorials
  - 1 hour per week (two sessions are available): Monday at 2 pm in ENCM 261 and Tuesday at 10 am in ENCM 105;
    There will be a tutorial in the first week of the semester
- LabVIEW instruction classes
  - 2 hours per week in the first four weeks of the semester; Thursday 9 am in ENCM G23;
- Mechatronics Laboratory safety induction session
  - Approximately 20 minutes. The induction sessions will be conducted in the first week of the semester. The exact dates and times will be announced by the unit coordinator. **Note: You need to attend the safety induction session to get access to the Mechatronics Laboratory.**

UNIT SCHEDULE

Most of the time you spend on this unit will be in laboratories and working in your own time. The laboratory time has been allocated for you. However, the actual times you spend in the laboratories when conducting the project work will depend on which group you are assigned to.

The unit timetable is available on the unit website and through WebCT.

The unit is OLCR (On-Line Class Registration) enabled. Please use OLCR to register your timetable preferences.

Major Tasks to Undertake in the Beginning of the Semester

1) Read The Guide to Project Work

2) "Enrol in"/assemble the project team. Note that Project Request Report must be submitted by **Friday July 24th, 5 pm** (WAST). This implies that the project teams must be assembled well before this deadline as you need time to write Project Request Report.

3) Attend the first (i.e. in the first week of the semester project meeting). This is of key importance as the purpose of this meeting is to assemble a project group.

4) Learn to use LabVIEW programming environment. 4 weeks of two hour learning sessions will be devoted to this. LabVIEW has been installed in all the main computer laboratories. (If you do not already have an account enabling access to computer in these laboratories, see the IT Manager Angus Stewart.) LabVIEW is essential for 3 out of 4 assignments in this unit. Several important concepts in the course will be introduced in the LabVIEW workshops so it is important that you do the practical exercises.

5) Read the detailed schedule provided for the unit: it provides guidance to help you with your work each week.

Project Allocation

You will be assigned to a team through the OLCR system, and most of your team members will be assigned as well. In addition to OLCR your team needs to submit a project allocation form requesting your desired project. Please ensure your timetable allows you to spend time working with your fellow team members during the semester. Note the importance of attending the first meeting (i.e. meeting in the first week of the semester). A list of projects is available on the mechatronics wiki http://wiki.mech.uwa.edu.au/index.php/Mechatronics:Visit_the_Mechatronics_Project_Wiki and through WebCT (Mechatronics Project page).

As explained in The Guide to Project Work every project group will have to prepare fortnightly project reports. The first report (referred to as a Project Request Form) is due on Friday of the 1st week of the semester. Students must report on the team assembled, and list 5 projects desired to work on, in order: 1-being the most desirable, 5 being less desirable. These preferences will be taken into account.