ENGG*6090 Special Topics in Mechatronics, Control and Robotics
Winter 2014

1 INSTRUCTIONAL SUPPORT

1.1 Instructor
Instructor: Mohammad Biglarbegian, Ph.D., P.Eng.
Office: THRN 2339, ext. 56248
Email: mbiglarb at uoguelph.ca
Office hours: By appointment

2 LEARNING RESOURCES

2.1 Course Website
Assignments, news, announcements, and grades will be regularly posted to the ENGG*6090 CourseLink site. You are responsible for checking the site regularly.

2.2 Required Resources
Students are required and expected to attend all the lectures. Students are responsible for whatever material is taught in the class. Note that the textbook may not have all the material taught in the class.
2.3 Recommended Resources


This material can be found in the library.

2.4 Additional Resources

Lecture Information: Students should attend the classes and make their own notes.

Miscellaneous Information: Other information related to Mechatronics are also posted on the web page.

2.5 Communications & Email Policy

Please use lectures and lab help sessions as your main opportunity to ask questions about the course. Major announcements will be posted to the course website. It is your responsibility to check your email regularly. As per university regulations, all students are required to check their <uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its student.

3 ASSESSMENT

3.1 Dates and Distribution

Assignments: 30%

Paper review and presentation: 20%

Project and presentation: 50%

Important Note: while you are encouraged to discuss with other classmates problems in the assignment or labs, there is zero tolerance for plagiarism or copying. A grade of 0 will be assigned to any assignment or report if they are copied or plagiarism is done by any means.

3.2 Course Grading Policies

Missed Assessments: If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. See the undergraduate calendar for information on regulations and procedures for Academic Consideration: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml
Accommodation of Religious Obligations: If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor at the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/acomrelig.shtml

Passing grade: In order to pass the course, you must obtain a grade of 65% or higher in total. Late submissions of assignments, reports, paper, project, presentation will not be accepted.

4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

4.1 Course Aims
This course covers special topics on mechatronics, robotics, and control. The course starts with the review of dynamic and presents Lagrangian dynamics; we also review state-space models of dynamic systems. We also present some fundamentals of nonlinear systems such as stability. We then present control and estimation design methods for linear systems. We then mainly focus on nonlinear control design techniques such as feedback linearization, robust control, and intelligent control. We also cover vehicle dynamics and control and discuss their most recent advancements. This course also covers advanced topics in path planning and localization for mobile robots. In specific terms, this course covers the following topics:

1. Review of Dynamic Systems: Lagrangian Systems
2. Review of Linear Control Systems: state space approach
3. Linear state estimation
5. Nonlinear Control Design Techniques: feedback linearization
6. Robust Control: sliding mode control
7. Intelligent Control
8. Applications: Vehicle Dynamics and Control (active/semi-active vibration control)
9. Applications: Mobile: Motion Planning and Control
10. State estimation for mobile robots
11. Flight Dynamics and Control (if time permits)

4.2 Learning Objectives
At the successful completion of this course, the student will have demonstrated the ability to:

1. Learn the fundamentals of Lagrangian systems with applications to robot manipulators
2. Learn linear estimation design
3. Develop nonlinear different control design techniques: robust and adaptive
4. Understand vehicle Dynamics and control and their applications
5. For a mobile robot develop algorithms for localization, path planning, etc.

4.3 Instructor’s Role and Responsibility to Students

The instructor’s role is to develop and deliver course material in ways that facilitate learning for a variety of students. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and project.

4.4 Students’ Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

E-mail Communication

As per university regulations, all students are required to check their <uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.

When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons, please advise the course in writing, with your name, id#, and e-mail contact. See the graduate calendar for information on regulations and procedures for Academic Consideration:
http://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/sec_d0e1415.shtml

Drop Date

The last date to drop one-semester courses, without academic penalty, is March 7th. Two-semester courses must be dropped by the last day of the add period in the second semester. Refer to the Graduate Calendar for the schedule of dates:
http://www.uoguelph.ca/registrar/calendars/graduate/current/sched/sched-dates-w11.shtml

4.5 Relationships with other Courses & Labs

Previous Courses:

ENGG*2340: Systems
5 T E A C H I N G A N D L E A R N I N G A C T I V I T I E S

5.1 Timetable

Lectures:
Wednesday 8:30 am–11:30am THRN 1126

5.2 Lecture Schedule

<table>
<thead>
<tr>
<th>Lectures</th>
<th>Lecture Topics</th>
<th>References(*)</th>
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<tr>
<td>1</td>
<td>Background and Review</td>
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<tr>
<td>2</td>
<td>Lagrangian Dynamics</td>
<td>Class lectures</td>
</tr>
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<td>3</td>
<td>Linear estimation and control design</td>
<td>Class lectures</td>
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<td>4</td>
<td>Nonlinear systems concepts</td>
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<td>Class lectures</td>
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<td>7</td>
<td>Intelligent Control</td>
<td>Class lectures</td>
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<tr>
<td>8</td>
<td>Vehicle Dynamics and Control</td>
<td>Class lectures</td>
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<tr>
<td>9</td>
<td>Robot Manipulator Control, Mobile Robots: Introduction</td>
<td>Class lectures</td>
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<td>10</td>
<td>Mobile Robot path planning</td>
<td>Class lectures</td>
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<tr>
<td>11</td>
<td>Estimation, localization of mobile robots</td>
<td>Class lectures</td>
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* Note: The chapters mentioned here are only used as a reference. The instructor may not necessarily follow exactly the material covered in the chapters. Students are responsible for whatever is taught in the class.
**Course Project**

The final project report must include all the technical details of your work. The report should be written very clearly and must have all the ingredients of a technical report/paper such as Abstract, Introduction, Literature Review, Background, Problem Definition, Methodologies, Simulations/Experiments, Discussions, Conclusions/Future Work. About 15%-20 of the report mark will be given to the quality of the writing (proper English grammar, punctuations, etc.). Marks will be deducted for grammatical, typos, or improper punctuations. It is expected from a graduate student to deliver a high quality report/paper that is flawless.

**Note:** There is no late policy for the course project. Late demonstration is not acceptable. Each student needs to demonstrate their project (whatever they have done by the deadline).

**Paper Review**

Each student will be assigned a research paper to review. The paper will be assigned by the instructor and is related to different areas of mechatronics. Students are supposed to carefully review the paper, learn about the topics, and generate the results, and create a new cast-study or example to demonstrate that they have fully understood the material. In the middle of the term, each student must present a short presentation on the paper to the class. Each presentation is limited to 20 minutes, with a few minutes for questions and answer.

**Assignment**

2-3 assignments will be given throughout the term. Students are expected to know Matlab to be able to do simulations. Assignments will be assigned in the class and have firm deadlines, as there is no late policy. Students are encouraged to discuss the assignments, but any source of plagiarism or copying from other student is not tolerated and will be treated according to the University of Guelph regulations.

<table>
<thead>
<tr>
<th>Item</th>
<th>Assigned / Start</th>
<th>Due / Finish</th>
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<tr>
<td>Project Proposal</td>
<td>Jan 15</td>
<td>Jan 22</td>
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<tr>
<td>Paper Review and presentation</td>
<td>Jan 22</td>
<td>February 26</td>
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<tr>
<td>Final Project Presentation</td>
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<td>Final Project Report</td>
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<td>March 19</td>
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**5.3 Other Important Dates**

Monday, January 6 2014: First day of class
Monday, February 17 – Friday, February 21 2014: Winter Break
Friday, March 7: drop date – 40th class
6 LAB SAFETY

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.

If the laboratory rules are not followed, consequences will include removing student’s access to the lab. If this results in lab work not being completed, the student will receive a grade of 0.

7 ACADEMIC MISCONDUCT

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community faculty, staff, and students to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University’s policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

The Academic Misconduct Policy is detailed in the Graduate Calendar:
http://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/sec_d0e1687.shtml

7.1 Resources

The Graduate Calendar is the source of information about the University of Guelph’s procedures, policies and regulations which apply to graduate programs:
http://www.uoguelph.ca/registrar/calendars/graduate/current/

8 ACCESSIBILITY

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability for a short-term disability should contact the Centre for Students with Disabilities as soon as possible.
9 RECORDING OF MATERIALS

Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

10 RESOURCES

The Academic Calendars are the source of information about the University of Guelph’s procedures, policies and regulations which apply to undergraduate, graduate and diploma programs:
http://www.uoguelph.ca/registrar/calendars/index.cfm?index