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 expected to attend all the lecturers. Students are responsible for whatever material taught in the class. Note that the textbook may not have all the material taught in the class.

2.3 Recommended Resources


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 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%

Midterm project report and presentation: 25%

Final Project and presentation: 45%

**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/c08-accomrelig.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.

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### 4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

#### 4.1 Calendar Description

This course covers the design of mechatronic systems, which are synergistic, combinations of components and controls drawn from mechanical engineering, electronics, control engineering, and computer science. The course emphasizes the integration of these areas through the design process employing the two skills of (1) modeling, analysis, control design, and computer simulation of dynamic systems, and (2) experimental validation of models, analysis and the understanding of the key issues of hardware implementation. The two skills are developed though assignments emphasizing analytical analysis with complementary laboratory exercises. The material covered includes mechatronic system design; a review of kinematics, electronics, modeling, simulation, signals and control; control architectures; sensors including vision; and actuators.

#### 4.2 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)

4.3 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. Nonlinear different control design techniques: robust and adaptive
4. Vehicle Dynamics and control and their applications
5. Mobile robot: localization, path planning, etc.

4.4 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.

4.5 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:

https://www.uoguelph.ca/registrar/calendars/graduate/2015-2016/pdffiles/genreg.pdf
Drop Date
The last date to drop one-semester courses, without academic penalty, is Friday, November 4. 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:
https://www.uoguelph.ca/registrar/calendars/graduate/current/pdffiles/sched.pdf

4.6 Relationships with other Courses & Labs

Previous Courses:

ENGG*2340: Systems
ENGG*3410: Control systems
ENGG*3410: Signal processing
ENGG*4480: Advanced Mechatronics
ENGG*4480: Advanced Mechatronic Systems Design

5 Teaching and Learning Activities

5.1 Timetable

Lectures:
Wednesday 10 am–1 pm THRN 1126

5.2 Lecture Schedule

<table>
<thead>
<tr>
<th>Lectures</th>
<th>Lecture Topics</th>
<th>References(*)</th>
<th>Learning Objectives</th>
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<td>Background and Review</td>
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<td>2</td>
<td>Lagrangain Dynamics</td>
<td>Class lectures</td>
<td>1,2</td>
</tr>
<tr>
<td>3</td>
<td>Linear estimation and control design</td>
<td>Class lectures</td>
<td>1,2</td>
</tr>
<tr>
<td>4</td>
<td>Nonlinear systems concepts</td>
<td>Class lectures</td>
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<tr>
<td>5</td>
<td>Feedback linearization</td>
<td>Class lectures</td>
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<td>6</td>
<td>Robust Control</td>
<td>Class lectures</td>
<td>4</td>
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<td>Class lectures</td>
<td>5</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>
<td>7</td>
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<td>Mobile Robot path planning</td>
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<td>11</td>
<td>Estimation, localization of mobile robots</td>
<td>Class lectures</td>
<td>8</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).

Midterm project

The purpose of the midterm is to prepare you for the final project. For the midterm, you should clearly define your project, (problem definition or statement), complete the modeling and generate some initial results. These initial results could be simulations. In the middle of the term, each student must present a short presentation on their midterm progress to the class. Each presentation is limited to 15-20 minutes, with a few minutes for questions and answers.

Assignment

Few 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.

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<tr>
<th>Item</th>
<th>Assigned / Start</th>
<th>Due / Finish</th>
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<tr>
<td>Project Proposal</td>
<td>Sept. 13</td>
<td>Sept. 20</td>
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<tr>
<td>Midterm</td>
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<td>Oct. 18</td>
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<td>Final Project Presentation</td>
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<td>Nov. 29</td>
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<tr>
<td>Final Project Report</td>
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<td>Dec. 5</td>
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Table 1(a): Important dates

Final exam

Final exam everything will be closed, i.e., closed-book, no notes, no formula sheet, etc.

5.3 Other Important Dates

Thursday, September 8, 2016: First day of class
Tuesday, October, 2016: Fall Study Break Day
Friday, November 4, 2016: 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:
https://www.uoguelph.ca/registrar/calendars/graduate/2015-2016/pdffiles/genreg.pdf

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