ENGG*4460 Robotics Systems
Fall 2016

School of Engineering

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1 Instructional Support

1.1 Instructor

Instructor:	Medhat Moussa, Ph.D., P.Eng.
Office:	THRN 1339, ext. 52435
Email:	mmoussa@uoguelph.ca
Office hours:	TBA on Courselink or by appointment

1.2 Lab Technician

Technician:	Hong Ma
Office:	RICH 1506, ext. 53873
Email:	hongma@uoguelph.ca

1.3 Teaching Assistants

GTA	Email	Office Hours
Patrick Wspanialy	pwspania@uoguelph.ca	TBA on Courselink
Aubrianna Bilyea	abilyea@uoguelph.ca	TBA on Courselink
Ali Al Hashim	aalhas01@mail.uoguelph.ca	TBA on Courselink

2 Learning Resources

2.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG*4460 Courselink site. You are responsible for checking the site regularly.

2.2 Required Resources

1. J. J. Craig *Introduction to Robotics Mechanics and Control*, 3rd Edition, Pearson Prentice Hall, 2005.

2.3 Recommended Resources

1. M. Spong, S. Hutchinson, and M. Vidyasagar, *Robot Modeling and Control*, Wiley, 2006.
2. Additional materials and articles will be posted on the website or during the lab.

2.4 Additional Resources

Lecture Information: Selected lecture notes will be posted on the course website.

Lab Information: The handouts for labs and tutorials will be given during the lab sections.

3 Assessment

3.1 Dates and Distribution

Quizzes: 15% (Best two out of the three quizzes will count)
Sept. 27, in class
Oct. 13, in class
Nov. 15, in class

Labs: 20%
See section 5.3 below for due dates

Midterm test: 25%
Nov. 1, in class

Final Exam: 40%
Thursday Dec 6, 14:30-16:30, Room TBA

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. See the undergraduate calendar for information on regulations and procedures for Academic Consideration of Religious Obligations:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml

Passing grade: The passing grade in this course is 50%

Missed tests: If you miss a test (whether a quiz or midterm) due to grounds for granting academic consideration or religious accommodation, the weight of any missed test will be added to the final exam weight. If you miss a test for reasons that are not grounds for academic consideration, then you will get a zero for that test. There will be no makeup midterm or quizzes.

Lab Work: You must attend and complete all laboratories. If you miss a laboratory due to grounds for granting academic consideration or religious accommodation, arrangements must be made with the teaching assistant to complete a makeup lab.

Late Lab Reports: Late submissions of lab reports will be subject to the following penalty policy.

- 25% will be deducted if the report is up to 24 hours late,
- 50% will be deducted if the report is 24 to 48 hours late,
- No reports will be accepted after 48 hours of the due date.

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4 Aims, Objectives & Graduate Attributes

4.1 Calendar Description

This course covers robot technology fundamentals, mathematical representation of kinematics, planning and execution of robot trajectories, introduction to robot languages, programming of robotic systems, different application domains for robots (e.g. assembly, manufacturing, medical, services, etc.), and robot sensors. The goal of this course is to provide students with a comprehensive background, approaches and skills to apply robotics technology to real world engineering applications and problems.
Prerequisite(s): ENGG*1500, ENGG*2400

4.2 Course Objectives

The course objective to provide students a solid theoretical base for further studies in Robotics. The course will follow a traditional format for robot modeling and analysis starting with Kinematics and moving to trajectory and control.

4.3 Learning Objectives

At the successful completion of this course, the student will have demonstrated:

1. Broad knowledge of current state of robotics technology and the interdisciplinary nature of robotics design and operation.
2. Ability to describe various components of a robotics system from both a hardware and software perspective.
3. Ability to operate safely a robotics arm using different coordinate frames.
4. Ability to program a robotics arm to perform various operations.
5. Knowledge of the robotics design process from forward kinematics to dynamics and control.
6. Ability to develop forward and inverse kinematics relations for simple and complex robots.
7. Ability to analyze and formulate the effect of differential motions and forces using the Jacobian techniques.
8. Ability to compute a trajectory plan of a robot arm given specific end-effector goals

4.4 Graduate Attributes

Successfully completing this course will contribute to the following CEAB Graduate Attributes:

Graduate Attribute	**Learning Objectives**	**Assessment**
1. Knowledge Base for Engineering	1, 2, 3, 6, 7, 8	Tutorials, Quizzes, Exams
2. Problem Analysis	6, 7, 8	Quizzes, Exams
3. Investigation	-	
4. Design	5, 6, 7, 8	Quizzes, Exams
5. Use of Engineering Tools	3, 4	Labs
6. Communication	-	Labs
7. Individual and Teamwork	-	Labs
8. Professionalism	-	
9. Impact of Engineering on Society and the Environment	-	
10. Ethics and Equity	-	-
11. Environment, Society, Business, & Project Management		
12. Life-Long Learning	1	-

4.5 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. Selected lecture notes will be made available to students on Courselink/D2L but these are not intended to be stand-alone course notes. 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 exams and labs.

4.6 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and tutorials. 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.

Attend lectures and tutorials in order to obtain all the course material that you are responsible for. - Check announcements page on a regular basis. - Submit reports on time. - Regularly, check your marks on the course web page and make sure they are up to date. - Submission of reports for re-marking must be done within a week of being returned.

4.7 Relationships with other Courses & Labs

Previous Courses: ENGG*1500: Solving systems of linear equations, matrix algebra, complex numbers

Follow-on Courses: The School is not offering any undergraduate advanced robotics course. Yet this course is part of the mechatronics stream for both Mechanical and ES&C students and as such other courses in mechatronics are complimentary to this course.

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5 Teaching and Learning Activities

5.1 Timetable

Lectures:			
Tuesday		4:00-5:20PM	ROZH, Room 102
Thursday		4:00-5:20PM	ROZH, Room 102
Laboratory and Tutorials:			
Wednesday	Sec 01	02:30PM - 05:20PM	RICH 2504
Tuesday	Sec 02	08:30AM - 11:20AM	RICH 2504
Thursday	Sec 03	08:30AM - 11:20AM	RICH 2504
Wednesday	Sec 04	08:30PM - 11:20PM	RICH 2504
Friday	Sec 05	02:30PM - 5:20PM	RICH 2504

5.2 Lecture Schedule

Lecture Topics	Learning Objectives
Course introduction and outline	1
Fundamentals of Robotics	1,2,3
Robot Programming	2,4
Spatial Description and Transformations	5
Forward Manipulator Kinematics	5,6
Inverse Manipulator Kinematics	5,6
Jacobians: Velocities and Static Forces	7
Trajectory Generation	8
Manipulator Dynamics and Control	5

5.3 Lab and Tutorial Schedule

The following lab schedule and topics are **tentative** and may change in content, due dates, and format. Labs are arranged in rotations. Every 3 weeks the students in each section will study a different robotics cell rotating between the four cells in the lab. Tutorial will run most of the weeks and will be scheduled in the last hour of the lab time and at the same location as the regular labs. Tutorials duration is one hour where the teaching assistant will solve practice problems with students. The following is an example of one section.

Week	Topic	Due
1	No Tutorial, Lab rotation 1 starts. Introduction to Universal robotic arm	-
2-3	Tutorial 1 and 2, Lab rotation 1 continues	-
4	Tutorial 3, Lab rotation 2 starts. Introduction to CRS robotic arm	
5	Holiday and study break - no tutorial, Lab rotation 2 continues	-
6	Tutorial 4, Lab rotation 2 concludes	
7	Tutorial 5, Lab rotation 3 starts. Introduction to Baxter robotic arms	
8	No Tutorials- preparing for midterm, Lab rotation 3 continues	-
9	Tutorial 6. Lab rotation 3 concludes	-
10-11	Tutorial 7, and 8. Lab rotation 4 starts. Introduction to Kuka robotic arms	-
12	No Tutorials - preparing for final exam. Lab rotation 4 concludes	

5.4 Other Important Dates

- Thursday, 10 September 2015: First class
- Monday, 12 October 2015: Holiday: no classes scheduled
- Tuesday, 13 October 2015: Fall Study Break Day no classes scheduled
- Friday, November 6, 2015: 40th class day, last day to drop
- Thursday, Dec. 3, 2015: Tuesday October 13 schedule in effect.
- Friday, Dec. 4, 2015 Classes rescheduled from Monday, October 12 Monday schedule in effect Classes conclude.

6 Lab Safety

The first lab of each rotation will focus significantly on lab safety and safe operation for the robotics arm associated with that rotation. Then students must take and pass with at least 75 % mark a safety quiz. Students will not be permitted to use the rotation robotic arm without passing the safety quiz. This test will not be counted towards your final grade but will prevent you from participating in the labs which will impact your lab mark. If you fail the test, you are allowed to retake it.

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.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member.

7.1 Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

A tutorial on Academic Misconduct produced by the Learning Commons can be found at:
http://www.academicintegrity.uoguelph.ca/

Please also review the section on Academic Misconduct in your Engineering Program Guide.

The School of Engineering has adopted a Code of Ethics that can be found at:
http://www.uoguelph.ca/engineering/undergrad-counselling-ethics

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

For more information, contact CSD at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: http://www.csd.uoguelph.ca/csd/

9 RECORDING OF MATERIALS

Presentations which are made in relation to course workincluding lecturescannot 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 Guelphs procedures, policies and regulations which apply to undergraduate, graduate and diploma programs:
https://www.uoguelph.ca/registrar/calendars/