Introduction to Robotics
(EECE 571R; 3 Credits)

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Course Description and Overview:

This course is an introduction to the field of robotics. It covers the fundamentals of kinematics, dynamics, trajectory planning, control of robot manipulators, and sensing. The course deals with homogeneous transformations, forward and inverse kinematics of robotic manipulators, differential kinematic equations, the manipulator Jacobian, and force relations. It also presents the fundamental principles on proximity, tactile, and force sensing. Students are expected to have a background in linear algebra, calculus, and basic physics.

Rationale:

Robotics as an application draws from many different fields and allows automation of various products as diverse as cars, manipulators used in factories, and medical robots. This course is a challenging introduction to fundamental computational concepts used broadly in robotics. The mathematical basis of each area is emphasized, and concepts are motivated using common robotics applications, practical examples presented in class, tutorial problems, and assignments exercises.

Student Learning Outcomes:

By the end of this course, the students will understand the basic concepts and theory governing the modelling of robots that perform autonomous tasks such as navigation and manipulation. By the conclusion of this course, each student should be able to:

- Describe the different physical forms of robot architectures.
- Kinematically model simple manipulator and mobile robots.
- Mathematically describe a kinematic robot system.
- Analyze manipulation and navigation problems using knowledge of coordinate frames, kinematics, optimization, and control.
- Compute forward and inverse kinematics for a small serial kinematic chain.
- Consider trade-offs among position control, velocity control, and force control when solving a robot control problem.
- Perform stability analysis of a controller-robot system, and describe why it is important.
- Describe how sensors used in robotics applications work.

Course Syllabus:

Introduction to Robotics course will cover the following 7 modules:

- **Module 1:** Fundamentals
- **Module 2:** Kinematics of Robots: Position Analysis
- **Module 3:** Differential Motions and Velocities
- **Module 4:** Dynamic Analysis and Forces
- **Module 5:** Trajectory Planning
- **Module 6:** Motion Control Systems
- **Module 7:** Sensors

Course Schedule:

Term 2 (Jan 06, 2020 to Apr 08, 2020)

Section	Activity	Days	Start Time	End Time	Classroom Location
EECE 571R	Lecture	Mon Wed Fri	11:00 am	12:00 pm	Building: MacMillan Room: 158
EECE 571R	Tutorial	Mon	17:00 pm	18:00 pm	Building: MacMillan Room: 158

Course Website:

The primary point of contact outside the classroom will be through Canvas at www.canvas.ubc.ca. All assignments, course notes, and grades will be posted on Canvas as well as any announcements relevant to the course.

Instructor's Office Location and Office Hours:

My office is located at MCLD 451 and my office hours are: Wednesdays and Fridays from 1:00 pm to 2:00 pm. If you need to reach me, my email address is: **siamak.najarian@ubc.ca** (or **siamakn@ece.ubc.ca**).

Teaching Assistant's Contact Information:

Mr. Shahed K. Mohammed will be your TA for this course and in charge of tutorial sessions, marking group assignments, and group quizzes and also the communications related to the formation of assignments groups. His email address is: **shahedkm@ece.ubc.ca**. For any issues related to tutorial sessions, marking of assignments, quizzes, and formation of assignments groups, please contact your TA directly.

Prerequisites:

For mechanical engineering students, the co-requisite is one of MECH 466, MECH 467.

Requirements:

Regular lecture attendance, regular tutorial attendance, completing assignments on time and delivering them before the deadlines, and successfully taking various exams and quizzes. **Students are expected to come to lectures and tutorials regularly, and to be always on time**.

Textbook and Other Course Materials:

All the course materials will be posted online. They will be in the form of class lecture notes. Various textbooks and references can be used for this course, but the **major reference for the course will be my course materials that will be posted on Canvas.** All the assignments will be available on Canvas in a timely manner. A few optional useful textbooks for this course are:

1. Introduction to Robotics: Analysis, Control, Applications (2nd Edition); 2011; by Saeed Niku; Publisher: Wiley.
2. Introduction to Robotics: Mechanics and Control (4th Edition); 2017; by John Craig; Publisher: Pearson.

Grading System:

Assignments	10%
Quizzes (3 x 5% each)	15%
Tutorial Participation	10%
Midterm Exam	25%
Final Exam	40%

All students are required to attend the final exam. Not attending the final exam leads to a mark of zero for this course. So even if some students reach a mark of 50 (out of a total of 100) before the final exam, they must still take the final exam in order to pass the course. In other words, the above grading scheme is only valid for those who attend the final exam.

Group Assignments:

All the assignments have been prepared by the course instructor, but your TA will be in charge of uploading them on Canvas and marking them. Assignments will be given out periodically and form an important part of the course (3 sets). Your solutions should be uploaded on Canvas before their deadlines. Late assignments will be given a mark of zero. Each group should consist of about **5 members** and the selection of the members will be decided by the students themselves. The electronic version of your group assignments solutions (one assignment solution per each group) should be submitted through Canvas before its due date. The names of the group members along with the name of the member in charge of correspondence with the TA (on behalf of your group) should be emailed to your TA. This should be done before the deadline set by your TA. If for any reason the list of assignments group members is not sent to your TA by the set deadline, he will set up the remaining group members himself and will let the students know the group arrangements a couple of days after the deadline is passed. Once a group is formed we encourage you not to change it. However, if for any reason you need to switch or change your group, you can do it only once by just informing your TA in advance. I suggest that the same members who form the assignments groups also form the quiz groups when possible. This is not mandatory but would make your TA's job more manageable.

Group Quizzes:

All quizzes have been prepared by the course instructor, but your TA will be in charge of giving them during tutorial sessions and marking them. There will be three group quizzes in total with **5 members** in each group. The quizzes will be mostly in the form of multiple choice tests. There will be no make-ups for missed quizzes.

Tutorial Sessions:

All the tutorial problems that will be discussed during the tutorials sessions have been prepared by the instructor. Your TA will be in charge of the TA sessions. The tutorial problems are very similar to your assignments problems. Tutorial participation will be measured based on taking attendance. It should be noted that there is a strong correlation between attendance and grades. In order to understand the material, you need to be present in class and tutorial sessions. Regular attendance is necessary in order to be most successful. Poor attendance will drastically affect a student's class participation grade. Please note that arriving late to a class is considered unprofessional.

Cell Phone Policy:

As a matter of courtesy, students are expected to turn off cell phones during class. If extraordinary circumstances require an exception to this policy, the student is expected to discuss this with the instructor or TA before class begins.

Summary of Important Dates:

Event	Date
Quiz 1	Monday, 10 February 2020
Midterm exam	Wednesday, 26 February 2020
Quiz 2	Monday, 16 March 2020
Quiz 3	Monday, 6 April 2020