Faculty of Engineering

Department of Mechanical Engineering

COURSE OUTLINE

MECH 580 A01 – ROBOTICS

Term – Summer 2024 (202405)

Instructor	Office Hours
Dr. Daniela Constantinescu	Days: W
E-mail: danielac@uvic.ca	Time: 11:30 am – 1:30 pm PT
	Location: EOW 537

LECTURE DATE(S)

Section: A01 / CRN 30650	Days: T, W, F	Time: 10:30 am – 11:20 am PT	Location: ECS 123

LAB SECTIONS

Section: B (Multiple)	Days:	Time:	Location: ELW A243
MECH 580 B01	M	1:00 pm – 3:50 pm PT	

Lab times and locations are also available from the timetable through Sign in to UVic, My Page.

TA Name	E-mail	Office Hours for marking TAs Tu 2:00pm-3:00pm in EWL 243
Yasin ANABESTANI – lab TA	yasina@uvic.ca	
Chen WANG – lab TA	wangch63@uvic.ca	
Homayoun HONARI – marking TA	hmnhonari@uvic.ca	
Umang PATEL – marking TA	umang13@uvic.cA	

Required Text	Optional Text
	Title: Robot Dynamics and Control.
	Author: M.W. Spong, S. Hutchinson, M. Vidyasagar
	Publisher/Year: 2004
Reference Materials:	

COURSE OBJECTIVES: This course introduces students to the modeling and control of robotic manipulators with serially connected links. The course investigates the kinematic and dynamic mappings between the joint (or configuration) space and the Cartesian (or task space) for the purpose of using them to control the robot to perform a desired motion or interaction task.

The MECH 580 topics build on rigid body kinematics and dynamics concepts from MECH 242, MECH 335 and MECH 450A, and on automatic control concepts from MECH 380 or ELEC 360. They also require familiarity with matrix algebra concepts from MATH 110 or MATH 211. Concepts from CSC 349A Numerical Analysis and MECH 458 Mechatronics will also be beneficial. The assignments and laboratory experiments require the use of Matlab, Simulink and the Robotics Toolbox.

The topics taught in MECH 430/580 are precursor to more advanced courses on robot manipulation, including medical robots, teleoperation, human-robot interaction/cooperation, autonomous robots.

LEARNING OUTCOMES: At the end of this course, students will be able to:
1. Determine the spatial transformation that models a given rigid body motion, and the transformation of coordinates that maps vectors from one coordinate frame to another.
2. Derive the Denavit-Hartenberg table, and compute the forward and inverse kinematics, of a robot with serially connected links.
3. Map robot configurations, velocities and forces between the configuration space and the task space.
4. Develop the configuration-space and the task-space Lagrangian dynamics of a serial manipulator.
5. Design a controller to command a desired robot motion and/or interaction with the environment.
6. Use Matlab and its toolboxes to simulate a robot with serially connected links.
7. Investigate the performance of a robotic manipulator using Matlab and its toolboxes.
8. Prepare assignment solutions and project reports according to the professional writing standards for engineering problem sets and formal reports posted on the MECH 430/580 Brightspace site.
9. Uphold the APEGBC Code of Ethics in their interactions with other students, their team members, the TAs and the instructor.

Weight & Date(s) of Assessments:	Weight	Date
Assignments:	30% (3 assignments at 10% each)	Date: May 31, June 28, July 26.
Labs	24% (4 labs at 6% each)	
Mid-term	45% (3 in-class quizzes at 15% each)	Date: June 14, July 12, August 2.
Final Exam	0%	NA

ASSIGNMENTS

1. Three problem sets will be distributed over the course of the term via the course Brightspace site. The assignments will require both hand calculations and Matlab to complete, and are designed assuming that the students will start to work on them **at least 2 weeks prior to the due date**. Please download Matlab from https://matlab.engr.uvic.ca/ and install it on your computer.
2. Assignments must be handwritten on "Engineer's pad" paper and submitted together with the Matlab plots as PDF files to be accepted. **Any other paper or file format will be rejected**.
3. **20% of assignment grades will be allocated to presentation**. Full presentation grades will be awarded to assignments that comply with all requirements for the preparation of engineering problem sets outlined on the course Brightspace site. Please clarify any unclear requirements with the instructor in advance of the assignment due date.
4. **Assignments are to be completed individually.** Please discuss any difficulties with the instructor or the TAs in advance of the assignment due date.
5. Photocopies of the handwritten assignments including the Matlab plots in PDF format, and the Matlab/Simulink files used to solve the assignments and generate the plots must be uploaded to the MECH 430/MECH 580 Course Space site by 11:59pm PST on the day the assignment is due. **Late Assignments will not be accepted.**
6. Assignment files submitted to Brightspace must be named using the following convention:
- handwritten solution including the Matlab plots: LastnameFirstname_Vnumber_MECH430_Assignment#.pdf or LastnameFirstname_Vnumber_MECH580_Assignment#.pdf;
- Matlab script – LastnameFirstname_Vnumber_MECH430_Assignment#.m or LastnameFirstname_Vnumber_MECH580_Assignment#.m;

- Simulink simulation diagram - LastnameFirstname_Vnumber_MECH430_Assignment#.slx or LastnameFirstname_Vnumber_MECH430_Assignment#.mdl or LastnameFirstname_Vnumber_MECH580_Assignment#.slx or LastnameFirstname_Vnumber_MECH580_Assignment#.mdl. **Please note that you will need (1) technology to scan your hand-written assignment solutions and convert them to PDF files; and (2) PDF Preview to append the Matlab plots saved as PDF files to the assignment solutions.**

LABORATORIES

1. The laboratory sessions will be carried out in ELW A243. The students will perform the pre-laboratory experiments indicated in the Omni Workbook available on Brightspace individually.
2. **The laboratory sessions and reports will be completed individually.**
3. The laboratory reports must be uploaded to the course Brightspace site 7 days after the students have completed the laboratory session. **A 10% penalty will be applied for each day of lateness to submissions after 11:59 pm PT on the due date.**

Lab #	Modules	Start	Due (11:59 pm PT)
1	Forward & inverse kinematics	06.03	7 days later (06.10)
2	Teach pendant in joint & task space	06.17	7 days later (06.24)
3	Jacobian & force rendering	07.01	7 days later (07.08)
4	Haptic well & haptic wall	07.22	7 days later (07.29)

NOTE:

Failure to complete all laboratory requirements will result in a grade of N being awarded for the course.

The final grade obtained from the above marking scheme for the purpose of GPA calculation will be based on the percentage-to-grade point conversion table as listed in the current Undergraduate Calendar.

COURSE LECTURE NOTES

Unless otherwise noted, all course materials supplied to students in this course have been prepared by the instructor and are intended for use in this course only. These materials are NOT to be re-circulated digitally, whether by email or by uploading or copying to websites, or to others not enrolled in this course. Violation of this policy may in some cases constitute a breach of academic integrity as defined in the UVic Calendar. **There will be no supplemental examination for this course.**

Approximate Course Schedule

Module	Topics	Date/Week
1	Spatial descriptions and transformations. Spatial descriptions: positions, orientations, frames. Coordinate transformations. Operators: translations, rotations, rigid body transformations.	05.05 – 05.21
2	Kinematics. Forward kinematics. Inverse kinematics. Velocity of a rigid body. Jacobians.	05.26 – 06.09
3	Statics. Transposed Jacobians. Static forces. Kineto-static duality.	06.15 – 06.16
4	Dynamics. Acceleration of a rigid body. Mass distribution. Lagrangian dynamics in joint and task spaces.	06.18 – 07.07
5	Control. Position and motion control in joint and task space. Interaction control.	07.13 – 07.28

General Information

Note to Students: Students who have issues with the conduct of the course should discuss them with the instructor first. If these discussions do not resolve the issue, then students should feel free to contact the Chair of the Department by email or the Assistant to the Chair to set up an appointment.

Centre for Accessible Learning (CAL) https://www.uvic.ca/accessible-learning/index.php

Accommodation of Religious Observance (AC1210) Read it here

Discrimination and Harassment Policy (GV0205) Read it here

Sexualized Violence Prevention and Response at UVic:
UVic takes sexualized violence seriously, and has raised the bar for what is considered acceptable behaviour. We encourage students to learn more about how the university defines sexualized violence and its overall approach by visiting https://www.uvic.ca/sexualizedviolence/. If you or someone you know has been impacted by sexualized violence and needs information, advice, and/or support please contact the sexualized violence resource office in Equity and Human Rights (EQHR). Whether or not you have been directly impacted, if you want to take part in the important prevention work taking place on campus, you can also reach out:
Where: Sexualized violence resource office in EQHR; Sedgewick C119
Phone: 250.721.8021
Email: svpcoordinator@uvic.ca
Web: https://www.uvic.ca/sexualizedviolence/

Office of the Ombudsperson:
The Office of the Ombudsperson is an independent and impartial resource to assist with the fair resolution of student issues. A confidential consultation can help you understand your rights and responsibilities. The Ombudsperson can also clarify information, help navigate procedures, assist with problem-solving, facilitate communication, provide feedback on an appeal, investigate and make recommendations.
Phone: 250-721-8357
Email: ombuddy@uvic.ca
Web: https://uvicombudsperson.ca/

Electronic devices in labs and lectures: No unauthorized audio or video recording of lectures is permitted.

Electronic devices in midterms and exams: Calculators are only permitted for examinations and tests if explicitly authorized and the type of calculator permitted may be restricted. No other electronic devices (e.g. cell phones, pagers, PDA, etc.) may be used during examinations or tests unless explicitly authorized.

Faculty of Engineering, University of Victoria Standards for Professional Behavior
It is the responsibility of all members of the Faculty of Engineering, students, staff, and faculty, to adhere to and promote standards of professional behavior that support an effective learning environment that prepares graduates for careers as professionals...
You are advised to read the Faculty of Engineering document https://www.uvic.ca/ecs/_assets/docs/student-forms/professional-behaviour.pdf which contains important information regarding conduct in courses, labs, and in the general use of facilities.

Graduate Students' Society

The Graduate Students' Society (GSS) serves all students registered in a Graduate degree program. For information on GSS activities, events and services navigate to https://gss.uvic.ca/

Grading System
The University of Victoria follows a percentage grading system in which the instructor will submit grades in percentages. The University will use the following Senate approved standardized grading scale to assign letter grades. Both the percentage mark and the letter grade will be recorded on the academic record and transcripts. Read the policy here

Course Experience Survey (CES)
We value your feedback on this course. Towards the end of term you will have the opportunity to complete a confidential course experience survey (CES) regarding your learning experience. The survey is vital to providing feedback to me regarding the course and my teaching, as well as to help the department improve the overall program for students in the future. When it is time for you to complete the survey, you will receive an email inviting you to do so. If you do not receive an email invitation, you can go directly to the http://ces.uvic.ca

You will need to use your UVic NetLink ID to access the survey, which can be done on your laptop, tablet or mobile device. I will remind you closer to the time, but please be thinking about this important activity, especially the following three questions, during the course.
- What strengths did your instructor demonstrate that helped you learn in this course?
- Please provide specific suggestions as to how the instructor could have helped you learn more effectively.
- Please provide specific suggestions as to how this course could be improved.

Attendance
Students are expected to attend all classes in which they are enrolled. An academic unit may require a student to withdraw from a course if the student is registered in another course that occurs at the same time...
An Instructor may refuse a student admission to a lecture, laboratory, online course discussion or learning activity, tutorial or other learning activity set out in the course outline because of lateness, misconduct, inattention or failure to meet the responsibilities of the course set out in the course outline. Students who neglect their academic work may be assigned a final grade of N or debarred from final examinations. Students who do not attend classes must not assume that they have been dropped from the course by an academic unit or an instructor. Courses that are not formally dropped will be given a failing grade, students may be required to withdraw and will be required to pay the tuition fee for the course. Read the policy here.

Academic Integrity
Academic integrity is intellectual honesty and responsibility for academic work that you submit individual or group work. It involves commitment to the values of honesty, trust, and responsibility. It is expected that students will respect these ethical values in all activities related to learning, teaching, research, and service. Therefore, plagiarism and other acts against academic integrity are serious academic offences.

The responsibility of the institution Instructors and academic units have the responsibility to ensure that standards of academic honesty are met. By doing so, the institution recognizes students for their hard work and assures them that other students do not have an unfair advantage through cheating on essays, exams, and projects.

The responsibility of the student Plagiarism sometimes occurs due to a misunderstanding regarding the rules of academic integrity, but it is the responsibility of the student to know them. If you are unsure about the standards for citations or for referencing your sources, ask your instructor. Depending on the

severity of the case, penalties include a warning, a failing grade, a record on the student's transcript, or a suspension.

It is your responsibility to understand the University's policy on Academic Integrity

Equality

This course aims to provide equal opportunities and access for all students to enjoy the benefits and privileges of the class and its curriculum and to meet the syllabus requirements. Reasonable and appropriate accommodation will be made available to students with documented disabilities (physical, mental, learning) in order to give them the opportunity to successfully meet the essential requirements of the course. The accommodation will not alter academic standards or learning outcomes, although the student may be allowed to demonstrate knowledge and skills in a different way. It is not necessary for you to reveal your disability and/or confidential medical information to the course instructor. If you believe that you may require accommodation, the course instructor can provide you with information about confidential resources on campus that can assist you in arranging for appropriate accommodation. Alternatively, you may want to contact the Centre for Accessible Learning (formerly the Resource Centre for Students with a Disability) located in the Campus Services Building.

The University of Victoria is committed to promoting, providing, and protecting a positive, and supportive and safe learning and working environment for all its members.