UNIVERSITY OF TORONTO INSTITUTE FOR AEROSPACE STUDIES
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ROBOTICS (AER 525)

INSTRUCTOR M.R. Emami, Ph.D., P.Eng. Phone: 416-946-3357
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LECTURE

Monday	12 – 14	Room: BA1240
Wednesday	09 – 10	Room: BA1230

TUTORIAL Wednesday 10 – 11 Room: BA1230

PORTAL The University of Toronto Portal: portal.utoronto.ca

LABORATORY

Monday	18 – 21	Lab: MC216	Group A and C
Tuesday	12 – 15	Lab: MC216	Group B and D

Students are divided into 4 groups: A, B, C, and D. Each group has up to 5 teams, and each team consists of 2 students. Each group attends the lab session every other week (four 3-hour sessions, starting Week 4 for groups A and B, and excluding Week09). One report per team per experiment is to be submitted online through the portal as a PDF at the end of each lab session. The laboratory experiments are:

Lab. #1	Introduction and Safety	**Lab. #2**	Task Programming I
Lab. #3	Task Programming II	**Lab. #4**	Workspace Identification

MARKING

Laboratory Attendance and Reports	20%	
Mid-term Test	35%	Wednesday November 2, 9-11
Final Exam	45%	

COURSE REFERENCE M.R. Emami, *AER525F Course Notes*, 2022.

SUPPLEMENTAL MATERIALS
- Lecture slides.
- Recommended (ungraded) problems and solutions for each chapter.

ADDITIONAL REFERENCES

i) J.J. Craig, *Introduction to Robotics - Mechanics and Control*, Fourth Edition, Pearson Prentice Hall, 2018. (Third Edition, 2005: TJ 211 C67 2005 ENGI)

ii) K.M. Lynch, F.C. Park, *Modern Robotics: Mechanics, Planning and Control*, Cambridge University Press, 2017.

iii) J. Angeles, *Fundamentals of Robotic Mechanical Systems: Theory, Methods, and Algorithms*, Fourth Edition, Springer, 2014. (Scholars Portal)

iv) B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo, *Robotics: Modeling, Planning and Control*, Springer, 2010. (Scholars Portal)

v) M.W. Spong, S. Hutchinson, M. Vidyasagar, *Robot Modeling and Control*, John Wiley & Sons, 2006. (TJ 211 .35 S75 2006X ENGI)

vi) A.A. Goldenberg, M.R. Emami, "Chapter 6: Kinematics and Dynamics", in *Handbook of Industrial Robots*, Nof S.Y. (ed.), John Wiley & Sons, Fourth Edition, pp. 79-98, 2006. (course portal)

COURSE DESCRIPTION

The course addresses fundamentals of analytical robotics as well as design and control of industrial manipulators and their instrumentation. Topics include forward, inverse, and differential kinematics, statics, inverse and forward dynamics, motion and force control of robot manipulators, mobile manipulators, actuation schemes, task-based and workspace design, and position and force sensors. A series of experiments in the Robotics Laboratory will also enhance the practical notions of the course content.

LEARNING OUTCOMES

Upon successful completion of the course, students will be able to conduct tasks including:
- comprehend theoretical aspects of kinematics, dynamics, and controls of robot manipulators;
- apply analytical notions to the structural and control design of industrial robot manipulators;
- understand the basic sensory equipment for robotic systems;
- enhance the performance of manipulators by augmenting them with additional sensor instrument; and
- work with the existing manipulators being used in the current industry.

INCLUSIVITY STATEMENT

All students and faculty at the University of Toronto have a right to learn, work and create in a welcoming, respectful, inclusive and safe environment. In this class we are all responsible for our language, action and interactions. Discriminatory comments or actions of any kind will not be permitted. This includes but is not limited to acts of racism, sexism, Islamophobia, anti-Semitism, homophobia, transphobia, and ableism. As a class we will work together to create an inclusive learning environment and support each other's learning. If you experience or witness any form of discrimination, please reach out to the Engineering Equity Diversity & Inclusion Action Group online, an academic advisor, a UofT Equity Office, or any UofT Engineering faculty or staff member that you feel comfortable approaching.

PHYSICAL AND MENTAL HEALTH

The University has been permitted to conduct in-person indoor lectures during the COVID pandemic, without limitations on physical distancing, given that all attendees have provided proof of their full vaccination (or University-approved exemption), complete daily health screening via UCheck (www.utoronto.ca/utogether/ucheck), and wear face masks during the lectures.

As a university student, you may experience a range of physical and/or mental health issues that may result in significant barriers to achieving your personal and academic goals. The University of Toronto offers a wide range of free and confidential services and programs that may be able to assist you. We encourage you to seek out these resources early and often.

Health & Wellness Resources: undergrad.engineering.utoronto.ca/advising-and-wellness/health-wellness
U of T Health & Wellness Website: studentlife.utoronto.ca/hwc .

All students in the Faculty of Engineering have an Academic Advisor who can advise on academic and personal matters. You can find your department's Academic Advisor at: uoft.me/engadvising .

ACCOMMODATIONS

Students seeking an accommodation can follow any of the processes below:

- If the student has a disability preventing them from a full return to campus in the Fall semester, the student must apply to Accessibility Services to be considered for accommodations. (4th floor, 455

Spadina Avenue, Suite 400, 416-978-8060, accessibility.services@utoronto.ca , www.studentlife.utoronto.ca/as)

- For travel-related including quarantine requirements, visa and health-related issues preventing a student from returning to campus at the beginning of the Fall semester, a student must apply to the Registrar's Office with supporting documentation for consideration of an accommodation.
- Students who have different exceptional circumstances that prevent them from attending activities on campus due to COVID-19 should also apply to the Registrar's Office with supporting documentation for consideration of an accommodation.
- Students in Toronto who are absent from academic participation for any reason (e.g., COVID, cold, flu and other illness or injury, family situation) and who require consideration for missed academic work should report their absence through the online absence declaration and submit a petition.

ACADEMIC INTEGRITY

Academic integrity is essential to the pursuit of learning and scholarship in a university, and to ensuring that a degree from the University of Toronto is a strong signal of each student's individual academic achievement. As a result, the University treats cases of cheating and plagiarim very seriously. The University of Toronto's Code of Behaviour on Academic Matters can be found at the following link, which outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences:

governingcouncil.utoronto.ca/secretariat/policies/code-behaviour-academic-matters-july-1-2019 .

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behaviour on Academic Matters. If students have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, they are expected to seek out additional information on academic integrity from the instructor or from other institutional resources.

STATEMENT OF ACKNOWLEDGEMENT OF TRADITIONAL LAND

The course wishes to acknowledge the land on which the University of Toronto operates. For thousands of years it has been the traditional land of the Huron-Wendat, the Seneca, and most recently, the Mississaugas of the Credit River. Today, the course classrooms and laboratory are still the home to many Indigenous people, and we are grateful to have the opportunity to teach and learn on this land.