EE464: Medical Robotics and Computer-Integrated Intervention

Instructor information	Name: Mahdi Tavakoli Office: ECERF W6-007 Telephone: 780-492-8935 E-mail: mahdi.tavakoli@ualberta.ca Office hours: Mondays and Wednesdays 1:30-2:30 pm Wednesdays and Fridays 10:30-11:00 am
TA and lab instructor	Lab Instructor: Ali Jazayeri (ali.jazayeri@ualberta.ca) TA: Arefeh Boroomand (borooman@ualberta.ca)
Schedule information	Lecture times: Mon Wed Fri, 12:00- 12:50 pm Lecture location: ETLE 1 008 Midterm exam: Monday October 22, 12:00 -12:50 pm in the lecture room Final exam: Will be scheduled by the Office of the Registrar and Student Awards
Course webpage	https://eclass.srv.ualberta.ca/ A number of PowerPoint presentations have been posted on this website already. They are incomplete now, will be completed in class, and re-posted to the website. I recommend that you print and bring your copy of the incomplete notes to the class, and add your notes on them as I am writing on the slides.
Course content	The course provides training in areas pertaining to the analysis and design of robotic systems for medical applications. To this end, the course will introduce: • Basics and paradigms of computer-integrated intervention • Main topics in robotics: Kinematics, dynamics, control • Applications of the above principles of robotics in medical systems • Control for haptic teleoperation of medical robots • Existing medical robotic systems and applications This is a more detailed chapter-by-chapter breakdown of the course coverage: • Basics of medical robotics • Paradigms of medical robotics • Spatial descriptions and transformations • Forward kinematics • Inverse kinematics • Jacobians • Remote Center of motion creation in minimally invasive surgery (MIS) robots • Port placement in MIS • Collision detection and untangling for MIS robots • Dynamics • Trajectory generation • Linear control of manipulators • Image-based visual servoing • Nonlinear control of manipulators • Force control of manipulators • Haptic teleoperation: Two port networks • Haptic teleoperation: Stability & transparency • Haptic teleoperation: Control architectures • Haptic teleoperation: Delay compensation The course and its lab will use the knowledge of and skills in mathematics, systems control, and some programming in both Matlab and C/C++ languages.

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<tr><td>Marking scheme</td><td>

Assignments: 10%
Laboratories: 15%
Midterm exam: 25%
Final exam: 50%

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<tr><td>Textbooks and selected references</td><td>

J. J. Craig, Introduction to Robotics: Mechanics and Control, Prentice Hall, 3rd edition, 2004, ISBN 0201543613.
M. Tavakoli, R.V. Patel, M. Moallem, A. Aziminejad, Haptics for Teleoperated Surgical Robotic Systems, World Scientific, 2008, ISBN 978-981-281-315-2.
Electronically Available through U of A Libraries.
B. Siciliano, O. Khatib (Eds.), Springer Handbook of Robotics, Springer, 2008, ISBN 978-3-540-23957-4.
Electronically Available through U of A Libraries (via Springerlink).
M. Grunwald (Ed.), Human Haptic Perception: Basics and Applications, 2008, ISBN 978-3-7643-7611-6.
Electronically Available through U of A Libraries (via Springerlink).
M. Lin and M. Otaduy (Eds.), Haptic Rendering: Foundations, Algorithms and Applications, A K Peters, 2008, ISBN 978-156-881-332-5.
R. H. Taylor, S. Lavallee, G. Burdea, R. Mosges (Eds.), Computer-Integrated Surgery, MIT Press, 1996, ISBN 978-0-262-20097-4.
G. C. Burdea and P. Coiffet, Virtual reality technology (2nd Edition), Wiley, 2003, ISBN 0-471-36089-9.

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<tr><td>MATLAB / Simulink and C/C++</td><td>

MATLAB/Simulink will be needed in this course for doing the assignments and the labs. Moreover, at least a basic understanding of the C/C++ language will be required in the labs for programming the Phantom Omni robots.

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<tr><td>Assignments</td><td>

Four assignments will be posted on the course website. Each assignment will be due one week after it is posted by 4:00 pm at the EE464 assignment box (located outside the ECERF reception area on the 2nd floor).
Assignments put in the box after 4:00 pm on the due date and before they are picked up will receive a 25% penalty. No late assignments will be accepted once the box has been emptied.
Consultation with other students is permitted; however, the solutions handed in must be your own work.

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<tr><td>Lab</td><td>
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<tr><th></th><th>Date</th></tr>
<tr><td>Lab1</td><td>Thursday Oct. 4</td></tr>
<tr><td>Lab2</td><td>Thursday Oct. 25</td></tr>
<tr><td>Lab3</td><td>Thursday Nov. 15 & TBD* (your group will pick one)</td></tr>
<tr><td>Lab4</td><td>Thursday Nov. 22 & 29 (your group will pick one)</td></tr>
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* The second section for Lab 3 will be held on a day between Nov. 14 and Nov. 21.

You must attend all of the four lab sessions.
Reports for Labs 1 to 3 will be due by 4:00 pm, one week after you perform the lab. The report for Lab 4 will be due by 4:00 pm on December 5. All reports should be put into the EE464 laboratory box outside the ECERF reception area.
Lab reports put in the box after 4:00 pm on the due date and before they are picked up will receive a 25% penalty. No late reports will be accepted once the box is emptied.
Lab reports should be clear, clean and stapled.

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Important policies	• Policy about course outlines can be found in Section 23.4(2) of the University Calendar. • The University of Alberta is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Code of Student Behaviour (online at http://www.uofaweb.ualberta.ca/secretariat/studentappeals.cfm) and *avoid any behaviour which could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence*. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University. • Recording is permitted only with the prior written consent of the professor or if recording is part of an approved accommodation plan. • Missed midterm exam and missed final exam can only be justified by documented medical evidence.
Calculator and formula sheet	• You may use *approved non-programmable* calculators (with a gold sticker) in the midterm and final exams as long as in compliance with the Faculty of Engineering's Calculator Policy: http://www.engineering.ualberta.ca/calculator.cfm. Obviously, calculators must not be used for any kind of cheating or communication with other students during exams. • In the midterm exam, you can bring one formula sheet (letter size, two sided). You can bring two such formula sheets in the final exam. No books, notes, or other materials will be allowed in either exam.