ECE464: Medical Robotics and Computer-Integrated Intervention

Instructor information	Name: Mahdi Tavakoli Office: 13-360 Donadeo Innovation Centre for Engineering (ICE) Telephone: 780-492-8935 E-mail: mahdi.tavakoli@ualberta.ca Office hours: Mondays, Wednesdays and Fridays 1:00-2:00 pm
TA and lab instructor	Lab Instructor: Jay Carriere (jtcarrie@ualberta.ca) TA: Thomas Lehmann (lehmann@ualberta.ca)
Schedule information	Lecture times: Mon Wed Fri, 12:00- 12:50 pm Lecture location: NRE 2 090 Midterm exam: Wednesday October 26th, 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 • Dynamics • Trajectory generation • Linear control of manipulators • 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.
Marking scheme	• Assignments: 5% • Laboratories: 20% • Midterm exam: 25% • Final exam: 50%

Textbooks and selected references	• **J. J. Craig, <u>Introduction to Robotics: Mechanics and Control</u>, Prentice Hall, 3rd edition, 2004, ISBN 0201543613.** • M. Tavakoli, R.V. Patel, M. Moallem, A. Aziminejad, <u>Haptics for Teleoperated Surgical Robotic Systems</u>, World Scientific, 2008, ISBN 978-981-281-315-2. *Electronically Available through U of A Libraries.* • B. Siciliano, O. Khatib (Eds.), <u>Springer Handbook of Robotics</u>, Springer, 2008, ISBN 978-3-540-23957-4. *Electronically Available through U of A Libraries (via Springerlink).* • M. Grunwald (Ed.), <u>Human Haptic Perception: Basics and Applications</u>, 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.
MATLAB / Simulink and C/C++	• 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.
Assignments	• Four or five 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 ECE464 assignment box. • 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.
Lab	<table><tr><td></td><td>**D1**</td><td>**D2**</td></tr><tr><td>**Lab1**</td><td>Oct 6</td><td>Oct 7</td></tr><tr><td>**Lab2**</td><td>Oct 20</td><td>Oct 21</td></tr><tr><td>**Lab3**</td><td>Nov 3</td><td>Nov 4</td></tr><tr><td>**Lab 4**</td><td>Nov 17</td><td>Nov 18</td></tr></table> • *You must attend all of the four lab sessions.* • Lab reports is due one week after the lab (see the lab's eClass for exact lab report due dates) and should be put into the ECE464 laboratory box. • 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.
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 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. Note the following new policy:
	o **83.3(11) Missed Term and Final Exams:** Refer to §§23.3 and 23.4. There are no deferred term exams for courses offered in the Faculty of Engineering. In instances where a student has a documented reason for missing a term exam(s) and at the discretion of the instructor, the value of a missed term exam(s) can be added to the value of the final exam. A missed term exam(s) is considered assigned term work which has not been completed in determining eligibility for a deferred final exam. If the resulting final exam weight exceeds that allowed under §23.4(1), then any accommodation will be at the discretion of the Dean of Engineering.
	o **23.4(1) Weighting of Term Work and Final Examinations:** In each course in which a final examination is held, a weight of not less than 30 percent and not more than 70 percent will be assigned to the final examination, except where a departure from this arrangement has been authorized by the council of the Faculty in which the department offering the course is situated. The remaining weight for the course will be assigned to term work.
	The above means that the authority to approve beyond a 70% total of mid term and final exams is at the discretion of the Dean (delegated to the Associate Dean, Student and Co-op Services).
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.