ME 571: Medical Robotics Fall 2021

Instructor:
Professor Sheila Russo
Department of Mechanical Engineering
730 Commonwealth Ave., EMA 219
Email: russos@bu.edu

Teaching Assistant:
Mark Baldiswieler
Email: markwb@bu.edu

Course schedule:
Lectures and labs:
Monday and Wednesday 12:20-2:05 (EPC 204)

Prof. Russo's office hours:
Wednesdays 3:15 – 4:15 PM. (Location TBD)
If you want to attend office hours, you need to send an email in advance to russos@bu.edu to help with scheduling during the allocated time.

Mark Baldiswieler's office hours: Mondays 11:20-12:20 PM (EPC B05)
If you want to attend office hours, you need to send an email in advance to markwb@bu.edu to help with scheduling during the allocated time.

Inclusion:
I consider this classroom to be a place where you will be treated with respect. Individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and other visible and nonvisible differences – are welcome. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class.

COVID 19 & BU Community Health Expectations:
Everyone will be required to wear a mask over the mouth and nose at all times. No eating and drinking allowed. Please make sure your mask fits snugly against your face. Gaiters, bandanas, neck fleeces, scarves, and masks with exhalation valves should not be used, given the potentially increased risk of aerosol transmission associated with these types of facial coverings.
Please refer to https://www.bu.edu/back2bu/student-health-safety/face-coverings/ for more information.
All students are expected to follow all university guidelines with respect to daily symptom checks, testing, and mask wearing when they leave their dorm or home. For a detailed description of official BU policies regarding COVID, please visit: http://www.bu.edu/dos/policies/lifebook/covid-19-policies-for-students/

Important: All students will be required to show proof, upon their entrance in class, that they are compliant with health attestations and testing. Students will need to show their green badges on their mobile devices prior to starting class.

Absence
It is possible that a student needs to miss class due to a personal situation, an illness or other related situation (e.g., they are close contact, etc).
Student should inform Prof. Russo via email as soon as possible if they need to miss class to accommodate reasonable solutions. Students will not be penalized for absences due to a COVID situation.

Textbook:
No textbook is required for this course. The instructor will provide course material.

Course web page:
Blackboard

Prerequisites: Mechanical Design (CAD), Experience in Fabrication, Experience with Programming/Automation, Technical Communication (e.g. writing and presentation). Consent of Instructor.

Course learning objectives:
This course will be composed of lectures, labs, tutorials, and hands-on work.
We will study the design, mechanics, materials, manufacturing, and control of robots and associated technologies for medical applications. We will cover theory on medical robotics and case studies, including examples from medical companies and research groups. This class is aimed toward graduate students in engineering; no medical background is required. We will study and explore design principles of different mechatronic components and systems for medical robots.
This course is designed to give students experience with the initiation of a new research project in the field of medical robotics. This will help them develop hands-on skills in robotics, such as:

- Problem identification, describing motivation and significance
- Prior art searches, performing a literature review
- Strategy and concept generation, developing supporting evidence
- Estimation
- Sketching
- Modeling
- Ergonomics and prototyping
- Data presentation, and oral presentation.

Product development will be on a medical related application: surgical robot, medical robot, wearable device, rehabilitative device, etc.

Instructional Format:
The instructor will provide course material (via Blackboard) in preparation for class (videos, notes, slides, reading assignments, and homework assignments). Students will be required to go through that material and prepare before they come to class.
Class time will be devoted to lectures, graded quizzes, discussion sections (quiz discussion, reading/homework assignment discussion, etc.), Q&A, labs and hands-on activities.

Policy on labs, hands-on activities, and final project:

- Materials (electromechanical parts, pneumatic components, consumable materials, etc.) to carry on labs and hands-on activities will be provided.
- You will have access to EPIC and EPC B05 (basement of EPIC) to work on labs, hands-on activities, and final projects.
- All materials will need to be returned at the end of the semester.
- Lab activities and materials will be coordinated by the teaching assistant (TA). If you have questions, please feel free to reach out via email to the TA and the instructor.
- These materials will also be used to pursue a final hands-on project, based on the contents presented in class. No additional materials and/or components will be provided by the instructor and/or the Department. However, you are allowed to purchase some materials on your own within your group, if you want to.

- Labs, hands-on activities, and final project will be carried out in groups (3-5 students). Instructor will provide guidelines and specific instructions.

Policy on quizzes:

- We will have regular quizzes to assess your understanding of lectures.
- Quizzes will be done in class via Google forms. Please bring your laptop.
- You are allowed access course materials while doing the quiz.

Grading:
Homework, quizzes, and participation (30%)
Labs (30%)
Final Project Pre-proposal (10%)
Final Project Report and Presentation (30%)

Homework:
Homework assignments will be announced through Blackboard.

- Due date and time will be specified on the assignment.
- Late homework will **not** be accepted.

Final project presentation:
The final project presentation will take place over an entire class period. Missing the final presentation due to vacation is not excusable. Arrangements will be made on a case-by-case basis for documented emergencies or University conflicts.

Boston University Academic Conduct Code:
Honesty is a core value of Boston University. Any violations of BU academic honesty and integrity standards ***will be pursued*** through appropriate University channels. This includes, but is not limited to: cheating, plagiarism and misrepresentation. If you have any questions as to what constitutes an honor code violation, please ask. ***Ignorance is not an excuse for cheating***. You may access the BU Academic Conduct Code at: http://www.bu.edu/academics/policies/academic-conduct-code/

Accommodations for Students with Documented Disabilities:
If you are a student with a disability or believe you might have a disability that requires accommodations, requests for accommodations must be made in a timely fashion to Disability & Access Services, 25 Buick St, Suite 300, Boston, MA 02215; 617-353-3658 (Voice/TTY). Students seeking academic accommodations must submit appropriate medical documentation and comply with the established policies and procedures http://www.bu.edu/disability/accommodations/

C**ourse Schedule:**
The following is an approximate schedule for the course.

Date	Lesson #	Topic
W Sep 8, 2021	1	Introduction to the class, logistics, and expectations
M Sep 13, 2021	2	1) Why Medical Robotics? Why are robots important in healthcare? 2) How to do a bibliographic research 3) Clinical innovation cycle and validation of medical robots

		Lab 0 (Orientation in EPC B05)
W Sep 15, 2021	3	General intro to mechanical side of robotics a) Joints and links b) Actuators c) Sensors d) Workspace
M Sep 20, 2021	4	Autonomous Medical Robots – 1 a) A bit of history b) ROBODOC Lab 1
W Sep 22, 2021	5	Autonomous Medical Robots – 2 c) CyberKnife
M Sep 27, 2021	6	Why do we need robots to perform surgery? Minimally Invasive Surgery and its open challenges – 1 a) Laparoscopy b) LESS Lab 2
W Sep 29, 2021	7	Why do we need robots to perform surgery? Minimally Invasive Surgery and its open challenges – 2 c) Flexible endoscopy d) NOTES
M Oct 4, 2021	8	Teleoperated Surgical Robots – 1 a) daVinci Surgical System from Intuitive Surgical b) Endowrist c) Evolution of the daVinci platform, daVinci robot patient platform d) daVinci robot surgeon console Lab 3
W Oct 6, 2021	9	Teleoperated Surgical Robots – 2 e) Ion platform from Intuitive Surgical f) Sport – Titan Medical g) RAVEN h) Monarch Auris i) Transenterix
T Oct 12, 2021	10	External speaker - TBD
W Oct 13, 2021	11	Robots for Laparo-Endoscopic Single-Site surgery (LESS)
M Oct 18, 2021	12	Robots for endoscopy a) Locomotion and navigation with flexible robots b) Manipulation and visualization with flexible robots Lab 4
W Oct 20, 2021	13	Continuum medical robots – 1
M Oct 25, 2021	14	Continuum medical robots – 2 Lab 5
W Oct 27, 2021	15	Robotic catheters – 1

		Discussions on final project definition
M Nov 1, 2021	16	Robotic catheters – 2 Lab 6
W Nov 3, 2021	17	Why do we need robots to assist during rehabilitation? Rehabilitation and wearable robots – intro and motivation Discussions on final project definition
M Nov 8, 2021	18	Rehabilitation and wearable robots – lower limbs Lab 7
W Nov 10, 2021	19	Rehabilitation and wearable robots – upper limbs **Final Project Pre-proposal due**
M Nov 15, 2021	20	Rehabilitation and wearable robots – hands – 1 Working on final project in class
W Nov 17, 2021	21	Rehabilitation and wearable robots – hands – 2 Working on final project in class
M Nov 22, 2021	22	1) Sterilization processes for medical robots 2) Considerations on materials biocompatibility for medical robots Working on final project in class
Thanksgiving		No class
M Nov 29, 2021	23	Working on final project in class
W Dec 1, 2021	24	Working on final project in class
M Dec 6, 2021	25	**FINAL PROJECT PRESENTATION**
W Dec 8, 2021	26	**FINAL PROJECT PRESENTATION** - **Final Project Report due**