**Medical Robotics**

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**Teaching Assistants**:

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Robotics and automation have been gaining popularity in medical applications for the last few decades. Minimally invasive surgery and movement neurorehabilitation are two areas of medicine where robots have been increasingly employed. This increasing role is expected to continue in various areas of medicine. Building robots to solve problems in medicine requires a strong base in robotics, in addition to a good understanding of the targeted clinical problem.

This is expected to be a foundational course introducing:

1. modern ideas and concepts in robot kinematics, dynamics, and control.
2. Fundamental concepts in robots for movement training in neurorehabilitation, and for minimally invasive surgery, and
3. Provide hands-on experience in building, characterizing, and controlling robotic devices through a set of lab experiments.

**Course Content**

**Theory:**

**Mathematical preliminaries**; **Kinematics**: Rigid Body Motions; Robot Forward Kinematics; Differential Kinematics; Inverse Kinematics; Trajectory Planning; **Dynamics & Control:** Robot Dynamics; Robot Control; **Rehabilitation Robotics**: robots for movement training; design considerations; human-robot interaction; the role of robots in recovery; **Surgical Robotics:** robots for collaborative task completion; design consideration; effectiveness of robotic surgery; **Future of medical robotics**.

**Lab:**

Introduction to Arduino programming; Communication protocols; Reading data from different sensors – digital encoders, hall sensors; Characterization of electrical actuators; Design and analysis of PID controller of single DOF robots; Estimation of robot kinematic parameters; Implementation and characterization of impedance and admittance controllers;

**Assignments**

This is a hands-on course heavy on pen-and-paper, programming, and lab assignments. Students are encouraged to use Python or Julia for their programming assignments.

**Resources**

The topics covered in this course are quite mature, so it’s no surprise that there are numerous wonderful resources. Here are some resources that cover the topics discussed in this course. There are several wonderful resources:

1. Lynch, Kevin M., and Frank C. Park. Modern robotics. *Cambridge University Press*, 2017.
2. Murray, Richard M., et al. A mathematical introduction to robotic manipulation. *CRC press*, 1994.
3. De Silva, Clarence W. Sensors and actuators: control system instrumentation. *CRC Press*, 2007.
4. Online lectures: [Modern Robotics](https://youtu.be/jVu-Hijns70) by Prof. Kevin Lynch.