

Syllabus

Course Number: BMED 4803 / BMED 8813

Course Title: Medical Robotics; Credits: 3

Class Day(s): Tuesday and Thursday; Time: 8:05AM-9:25AM; Location: ES&T L1125

Instructor Information

| | | |
|---|--|---|
| Instructor Jaydev P. Desai Professor, BME Distinguished Faculty Fellow | Email jaydev@gatech.edu Phone 404-385-5381 | Office Hours & Location Office: U. A. Whitaker Bldg. Room 3112 Office Hours: Tuesday: 9:35AM-10:35AM |
| Teaching Assistant(s) None | TA Email N/A | TA Office Hours & Location N/A |

General Information

Description

The evolution of robotics in surgery is a new and exciting development. Medical robotics brings together many disparate areas of research such as design, development, and evaluation of robotic systems, control, haptics (sense of touch), medical imaging, safety in medical robotics, and ergonomics in minimally invasive procedures, to name a few. In addition to providing the students with a fundamental understanding of robotics and an overview of the application of robotics to the medical domain, this course will also introduce the students to different areas within medical robotics.

Pre- &/or Co-Requisites

BMED 3110 and BMED 3400

Course Goals and Learning Outcomes

The primary goal of this course is to provide the students with fundamental knowledge of robotics that can be used to design and develop medical robotic systems. Upon successful completion of this course, you should be able to:

- Have a fundamental understanding of robot kinematics and dynamics
- Understand the challenges in the design of a medical robotic system given the specific requirements for a particular application
- Appreciate the design, development, and evaluation of a medical robotic system

Course Requirements & Grading

| Assignment | Weight |
|---|---|
| Homework Quizzes | 30% (All quizzes will have equal weightage) |
| Group project, Final project presentation, and Project report | 30% (20% for the group project, 5% for the final project presentation, and 5% for the project report) |
| Individual Research paper (For Graduate students only) | 10% |
| Mid-term exam | 15% |
| Final exam | 25% (15% for Graduate students) |

Description of Graded Components

- There will be homework (HW) quizzes on the day by which an assigned homework should have already been completed, one group project (with at most 5 students in each group), final project presentation, project report, **individual research paper** (only for graduate students), one mid-term exam, and one final exam in this course. Late submission of project report or **individual research paper** and make-up quizzes or exams will in general not be permitted, unless there is permission from the instructor (see “Extensions, Late Assignments, & Re-Scheduled/Missed Exams” section below). Solution to the HW problems will be provided at least 5 days before the HW quiz for that specific HW. Students are strongly encouraged to attempt solving the HW problems, since the HW quiz will test their knowledge and understanding of a subset of the assigned HW or the complete HW.
- No calculators or any electronic computing device will be permitted for use during any HW quizzes or exams.
- All HW quizzes will be closed book and closed notes.
- Graduate students in the class will have **10%** of their grade assigned to an **individual research paper** that they will need to write and hence their final exam grade will have only **15%** weightage. The graduate student after discussing with the course instructor will most likely choose the topic of their **individual research paper** before the end of the fourth week of start of the semester. **The individual research paper should demonstrate independent thinking and problem solving ability for a specific problem in the area of medical robotics.**
- The **individual research paper** from each graduate student is due by 5pm on the last date of the class for this course, and it should be submitted by email only to jaydev@gatech.edu.
- For group projects, it is your responsibility to return all the critical hardware components at the end of the course. The final grade for your entire group will not be released till your group has returned all the critical items by Noon on the day following the last date of the class for this course. Your participation in the group project is critical to the success of the project. All members of the group will receive the same score for the group project, final project presentation, and the project report component of the course.

Grading Scale

Your numeric score in the course will be computed ONLY according to the weightage of the various graded components mentioned above. Any requests for supplemental course work to increase the student grade will not be entertained.

Your final grade will be assigned as a letter grade based on your numeric score in the course according to the following scale.

| | |
|----|---|
| A: | Numeric score $\geq 85\%$ |
| B: | $75\% \leq \text{Numeric score} < 85\%$ |
| C: | $65\% \leq \text{Numeric score} < 75\%$ |
| D: | $55\% \leq \text{Numeric score} < 65\%$ |
| F: | Numeric score $< 55\%$ |

Course Materials

- ***There is no course text book. Additional reading materials are mentioned below:***
- **Additional reading materials:**
 - ***Medical Robotics: Minimally Invasive Surgery***, by Paula Gomes (Editor). Woodhead Publishing. ISBN: 9780857091307
 - ***Medical Robotics***, by Achim Schweikard and Floris Ernst, Springer, ISBN 978-3-319-22891-4.
 - ***Robot Modeling and Control***, by Mark W. Spong, Seth Hutchinson, and M. Vidyasagar. Wiley Publishers. ISBN (10-digit): 0471649902; ISBN (13-digit): 978-0471649908

Group project, Final project presentation, and Project Report:

All the hardware and software required for the group project will be provided to you. Each team will have a budget of \$400 and must NOT exceed this budget. Group project selection must be completed by the end of the third week of the course at the latest. It is your responsibility to return all the critical hardware components at the end of the course. The final grade for your entire group will not be released till your group has returned all the critical items by Noon on the day following the last date of the class for this course. For developing the robot prototype, you are encouraged to use the department machine shop as well as 3-D rapid prototyping facilities in the department as well as Invention Studio (<http://inventionstudio.gatech.edu>). During the semester, depending on the availability, you may work in the Lab classroom (Location and schedule will be confirmed at a later date) to present the progress on your group project OR we may also have these discussions in the regular classroom location. For example, in one of those classes you could discuss ideas/brainstorm on feasible solutions for your group project.

Orders for all materials and supplies MUST be made through Georgia Tech. No individual purchases will be reimbursed without prior written permission of the instructor. You can purchase most of the items required for your group project through McMaster (<http://www.mcmaster.com/>), DigiKey (<http://digikey.com/>), or Amazon.com (<http://www.amazon.com>).

The project report must be no more than 6 pages in length in a two-column format. For example, papers published in *IEEE Transactions on Robotics*, is a good example of a sample paper format. The report must contain the following sections: Abstract, Introduction, Materials and Methods, Experiments and Results, and Conclusions.

The format of the final project presentation will be provided at a later date.

Course Expectations & Guidelines

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. For information on Georgia Tech's Academic Honor Code, please visit <http://www.catalog.gatech.edu/policies/honor-code/> or <http://www.catalog.gatech.edu/rules/18/>.

Any student suspected of cheating or plagiarizing on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

Accommodations for Individuals with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at (404)894-2563 or <http://disabilityservices.gatech.edu/>, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

Attendance and/or Participation

Attendance is not mandatory. However, it is highly recommended since class time is your opportunity to clarify concepts, ask questions, and engage in discussions.

Assignment Turn-In

The project report and the **individual research paper** (for graduate students only) must be emailed by 5pm on the last date of the class for this course. **No hardcopy of the project report or individual research paper will be accepted.** **All group projects must be presented to the instructor and the students in the class, in the class prior to the Final Instructional Day for this course in that semester.**

Collaboration & Group Work

- The students are allowed and encouraged to collaborate with each other on solving the homework problems, since it enriches the learning experience. However, it is important that each student understands how to solve those HW problems, since the HW quizzes will test their knowledge and understanding of a subset of the assigned HW or the complete HW.
- No collaboration of any type with another student will be permitted for the HW quizzes, mid-term exam, and final exam.
- For the group project, final project presentation, and the project report, the students in different groups are allowed to help and clarify concepts on a limited basis as long as it does not overly burden the other group.
- The graduate students are allowed to clarify any concept to the other graduate students for the **individual research paper**.

Extensions, Late Assignments, & Re-Scheduled/Missed Exams

- All extensions for the group project and final project presentation, project report, and re-scheduling missed HW quizzes or exams must be discussed in person with the instructor. Only on the approval of the instructor will the extension and/or re-scheduling be permitted. Your score will be **zero** for any project report or **individual research paper** (for graduate students only) that is turned in late, not all group members being present for the final project presentation, or a HW quiz or exam that is missed, unless the instructor has agreed to grant an extension for turning in those items or re-scheduling missed quizzes or exams. For example, if you miss any of the HW quizzes or exams, or the deadline for submitting your project report or **individual research paper** (for graduate students), or not all group members are present for the final project presentation, etc. due to health or religious reasons, or a family emergency, appropriate acceptable documentation **may** be required **by the instructor**. Failure to provide the appropriate acceptable documentation, **if requested by the instructor**, will result in a score of **zero** for that specific assignment.
- All group members must be present in the final project presentation unless there is a valid justification for being absent. The final decision on whether the absence is valid or not rests with the instructor.

Student Use of Mobile Devices in the Classroom

The use of mobile device(s) and laptop(s) in the class, without the instructor approval, is strictly prohibited, since it causes unnecessary distraction for other students as well as the instructor.

Student-Faculty Expectations

At Georgia Tech we believe that it is important to continually strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See <http://www.catalog.gatech.edu/rules/22/> for an articulation of some basic expectations - that you can have of me, and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech, while in this class.

Course Outline

The following material will be covered in the course:

1. Introduction to Medical Robotics
2. Minimally Invasive Surgery
3. Review of Mathematical Preliminaries
4. Robot Forward Kinematics - Position, velocity, and acceleration analysis
5. Robot Inverse Kinematics and Manipulator Jacobian
6. Introduction to various imaging modalities - Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and Ultrasound
7. Image-guided surgical robotics
8. Robot dynamics
9. Introduction to Haptics and its applications in medical robotics

Guest Lectures are planned in the course and their schedule will be provided as it becomes available.