**Introduction to Medical Robotics & Surgical Technologies**
Lecture: Wilkinson 130, Tuesday and Thursday 1:25pm–2:40pm


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**Course description:** This course is a broad introduction to medical robotics and surgical technologies, developed specifically for trainees in the NSF NRT for Advancement of Surgical Technologies. This course covers technical instruction in core areas of surgical technology and requires the completion of 3 mini-projects where trainees address real-world problems in surgery. It is designed to provide trainees with the required academic foundation to navigate the field of surgical technology and transition to more in-depth impactful, research during their second year. Broad subjects covered are listed below.

**Learning Objectives:**

- Describe solved and research level problems in robotics, ML, imaging, and specific surgical applications
- Debate pros/cons of different surgical robotics applications with respect to current clinical workflow
- Define a problem and generate a solution that interfaces a specific surgical need and engineering application regarding IP, Regulatory and Design considerations
- Outline a research project based on your prior experience applied to a specific problem in surgery
  - Specifically: with potential hypothesis and further, experiments. Additionally, define potential collaborative clinical/engineering advisors
- Overall: After students are exposed to clinical and engineering partners with surgical and robotic applications, students will generate 1 year research project proposal.

**Topics:**

- Surgery: Insight into the surgical life-cycle through instruction by specialist surgeons from multiple surgical areas. Trainees will also receive basic training on using various surgical tools and surgical robots.
- Robotics: Robotic applications in surgery, including manipulator dynamics, control systems, sensor systems, AI, and human-robot interaction
- Machine Learning and Artificial Intelligence: Fundamentals of techniques used in Machine Learning and Artificial Intelligence with a focus on practical applications of these techniques in the medical domain.
- Medical Imaging: Techniques for medical image acquisition and analysis, including computer-aided diagnosis, X-ray, CT, MRI and ultrasound.
- Medical Technology Development: Instruction in approaches and techniques used in the development of medical technologies such as 3D printing of multiple materials, 3D Computer aided design and analysis software and multiple facets of the design lifecycle.
- Problems in Surgery: Introduction to a range of issues within the surgical life-cycle to facilitate future project-based work and research.
- Medical Law, Policy and Ethics: Intersection of law, policy, and ethics as it relates to the development and use of medical technologies.
- Shadow a Surgeon: Exposure to a variety of holistic analysis techniques, develop needs assessments and identify research opportunities in multiple live surgical procedures

**Class Schedule**

| Week | Date | Class Topic | Class Specifics | Due |
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| 1 | Aug 26 | Introduction | Why/When use a robot? | |
| | Aug 28 | Project 1 | Intro and Prototyping Visit | Syllabus Quiz |
| 2 | Sep 2 | Robotics | Robotics Toolkit | SEAL Signup |
| | Sep 4 | ML/AI | ML: Classification | |
| 3 | Sep 9 | Neurosurgery | Dr. Patrick Codd | HW 1 |
| | Sep 11 | Surgical Robot | Dr. Steven Thorton | |
| 4 | Sep 16 | SEAL LAB | sign up! | HW 2 |
| | Sep 18 | Imaging | Tanner Zachem | |
| 5 | Sep 23 | ML/AI | Regression | HW 3 |
| | Sep 25 | ML/AI | Dr. Brinae Brent | |
| 6 | Sep 30 | ENT | Dr. Rigby | HW 4 |
| | Oct 2 | Project 1 | Presentations | Presentations |
| 7 | Oct 7 | Project 2 | Introduction | |
| | Oct 9 | Medical Imaging | Dr. Roarke Hortmeyer | |
| 8 | Oct 14 | Fall Break | | |
| | Oct 16 | MedTech Dev | Fundamentals/Market | |
| 9 | Oct 21 | Entrepreneurship | Dr. Bill Walker | HW 5 (only market) |
| | Oct 23 | MedTech Law | Kevin Flynn, Esq. | |
| 10 | Oct 28 | MedTech Ethics | FDA | HW 6 |
| | Oct 30 | Project 3 | Introduction | |
| 11 | Nov 4 | Project 2 | Presentations | HW 7, Presentations |
| | Nov 6 | Research Product | Examples | |
| 12 | Nov 11 | Lit Review | Presentations | HW 8 |
| | Nov 13 | Lit Review | Presentations | |
| 13 | Nov 18 | Project 3 | Presentations for feedback | HW 9 |
| | Nov 20 | Project 3 | Presentations for feedback | |
| 14 | Nov 25 | Applied Rob Setup | (remote b/c Thanksgiving week) | |
| | Nov 27 | Thanksgiving Break | | |
| 15 | Dec 2 | Applied Robotics | Exercise | |
| | Dec 4 | Applied Robotics | Exercise | HW 10 |

**Grading:**

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| Homework | 15 |
| Shadowing and user feedback interviews | 10 |
| Project 1: Proposed Problem and Solution in Surgery | 20 |
| Project 2: Startup Pitch Deck | 20 |
| Project 3: Project Proposal with Collaborators | 25 |
| Peer Feedback | 10 |

**Homework:** Homework will be assigned to help you learn the technical course material and prepare you for in class learning experiences. Since the primary purpose is to give you a chance to practice the skills introduced in the lectures, your lowest assignment grade will be ignored when calculating your overall assignment grade. You should expect 1-2 homework(s) assignments per major topic in the course. You are welcome to work with classmates, but 1) credit anyone who helped you with a footnote, and 2) be mindful of whether you are developing each skill. You will turn in your homework assignments through GradeScope (accessed through Canvas). Code, graphs, or other files should be included in the same file as the rest of your homework. For most software, you can create pdf printouts and append them together to create a single file. Assignments submitted over 2 days late or through any other means will not earn the privilege of TA feedback and will count as 0 grades. Assignments submitted within two days of the deadline, but late will receive a maximum 80%. The lowest assignment grade will be dropped.

**Projects:** There will be 3 group projects (groups may change in between projects) throughout the semester. The first will focus on defining key surgical problems as defined by multiple clinicians and designing initial solutions to present to the class. The second will be in form of pitch deck of a startup, presenting IP, market, and regulatory considerations for a particular medical solution. The third will be a project proposal, that

will be completed next semester by TAST students, with collaborators identified and initial project plans. All projects will be introduced in class and have a respective rubric and expectations document provided on Canvas at the beginning of the project work.

**Shadowing and User Feedback Interviews:** Shadowing of clinicians will be organized by Stacey Traister or individually set up for two 3+hr experiences over the course of the semester. Additionally, 4 total user interviews are expected for the first two projects (2 per project) using the template provided in canvas.

**Late Work Policy:** Late work (with the exceptions of presentations) will be accepted up to two days late. Please contact the instructors for any recurring late work or TAs for makeup work from missing class or weekly updates. Instructors will work with students to make up presentations as needed, but as many presentations are group based and timeline sensitive, it is recommended that students start their efforts early should any emergency arise.

**Course Expectations:**

Community Standard
It is the expectation that students, TAs, and the instructor will regard each other with mutual respect. Students will abide by the Duke Community Standard: I will not lie, cheat, or steal in my academic endeavors; I will conduct myself honorably in all my endeavors; and I will act if the Standard is compromised.

Communication
EdDiscussions (accessed through Canvas) is a communication platform that allows class peers to benefit from general questions about the course and timely response from instructors. Students can ask questions as themselves or anonymously and instructors will aim to get back to them within 2 business days or 12 hours after the end of a weekend or break. If you have a personal question, you can ask it via email or privately on eddiscussions, but if it is a question that would benefit your peers, instructors will ask you to post this to eddiscussion for the class to benefit.

Absences and Late Work
Absence due to illness will need to be reported within the same day of missed lecture or assignment deadline by submitting a Short Term Illness Notification Form (STINF); late work will not be accepted after two days of deadline and will be assigned a 0, unless proper STINF documentation is supplied. Varsity athletes must comply with all regulations given by Trinity College. In addition to these formalities, students need to communicate with the instructor in person or by email. Extenuating circumstances (such as family emergencies) that will prevent a student from attending class or lab or reaching assignment deadlines should be discussed with the instructor as soon as possible and will be accommodated on a case-by-case basis.

Disability Statement
Students with disabilities who believe they may need class accommodations should read through the Student Disability Access Office webpage (in particular, the Rights and Responsibilities for Students section) or contact the Office directly at (919) 668-1267. Note that accommodation requests should be submitted very early in the semester.