2.75J (H), 2.750J, 6.025J, 6.252J, HST.552 (UG CI-M AUS) Medical Device Design - Fall 2020 COVID Syllabus

Units: 3 - 0 – 9
Prerequisites: 2.008, 22.071, or permission of instructor
Updated: 1 September 2020

From the catalogue this course: Provides an intense project-based learning experience around the design of medical devices with foci ranging from mechanical to electro mechanical to electronics. Projects motivated by real-world clinical challenges provided by sponsors and clinicians who also help mentor teams. Covers the design process, project management, and fundamentals of mechanical and electrical circuit and sensor design. Students work in small teams to execute a substantial term project, with emphasis placed upon developing creative designs - via a deterministic design process - that are developed and optimized using analytical techniques. Instruction and practice in written and oral communication provided. Students taking graduate version complete additional assignments. Enrollment limited.

To take this class, all students are required to read this syllabus in its entirety: taking the class implies that they have read and understood all the requirements.

Important changes for Fall 2020:

1. There will not be an EECS instructor for 2.75 this semester (co-listed as 6.525J & 6.025), but the class still can count towards EECS degree requirements (see https://eecsappsrv.mit.edu/cgi-bin-secure/eecsis/degree_requirements.cgi). While EECS students are welcome in the class, without EECS staff this semester we cannot offer projects with an overall EE focus.
2. COVID-19 (C19) is, of course, causing lots of challenges and MIT has announced only seniors and grad students can come back for Fall 2020, and the semester will only run Sept. 1 to Nov 20, so we lose three weeks of development time. In addition, lab and maker spaces will be very limited. Hence, projects have to be more focused and start from day 1.
3. Project summaries are posted to the course website, https://meddevdesign.mit.edu, and detailed project descriptions are posted to the secure Canvas site, https://web.mit.edu/canvas. Students are asked to review these project descriptions on the Canvas site before the first class. Access will be granted by September 1.
4. Projects will be discussed on Wednesday, September 2, the first day of class, and students will indicate their project preferences by Friday. Teams will be formed by Monday, 7 September.
5. Students cannot gather in lecture hall for course lectures, so we will have Zoom-based lectures. We will use the chat features to gather questions in real time for discussion by the lecturer. Lectures will be supplemented by pre-recorded lectures, for example Prof. Slocum's FUNdaMENTALS of design lectures are available on YouTube.
6. As students commit to the class, we will send them a boxed "learning kit" with all the materials necessary to execute the two hands-on lab assignments, along with other goodies to facilitate learning. Kits will be posted to remote learners, delivered to dorms and available for local pickup. These will be received by the second week of class.

A special note:

MIT is a community and, as President Reif pointed out, it will be a group effort, with sacrifices, to keep those of us who are on campus as safe as possible, as well to ensure that community members who are remote are not isolated. Whether teacher or learner, we will all be tired and stressed. We ask for your understating, as we test new means of education, and feedback as to what is working and not working for you, so we can do our best to adjust. We commit to being candid with you when we will, invariably, make mistakes. We will also make an extra effort to be available to any student, local or remote, for extra support. Please reach out!

Teaching Staff

MechE Instructor	**MechE Instructor**	**MechE/IMES Instructor**	**ME/IMES Instructor**	**Comm. Instructor**
Prof. Alexander Slocum Room: 3-445 Phone: 603-591-7505 slocum@mit.edu	Dr. Nevan Hanumara Room: 3-470 Phone: 617-258-8541 hanumara@mit.edu	Prof. Ellen Roche Room: E25-344 Phone: 617-258-6024 etr@mit.edu	Prof. Gio Traverso Room: 3-340 Phone: 617-417-8061 cgt20@mit.edu	Dave Custer Room: 24-611 Phone: 617-253-2872 custer@mit.edu
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Macramé Coach	**Class Doc**	**Design Guru**		
Debie Slocum dslocum@mac.com	Jay Connor, MD jcmdhandsurg@comcast.net	Coby Unger cobyu@mit.edu		

Website: https://meddevdesign.mit.edu
Materials: https://web.mit.edu/canvas
Wiki: https://wikis.mit.edu/confluence/display/275/

Lecture: Monday & Wednesday 13:00 – 15:00 EST online. Zoom links provided via Canvas.
The lecture time is 90 minutes and we allow for 30 minutes after for Q&A. We will be available starting at 12:45.

Lab on-line: **Optional** - Monday 19:00 – 21:00 EST online. Zoom links provided via Canvas.

This class emulates a real-world product development effort, with students working in fast paced, professional R&D teams to develop a proof of concept prototype. Lectures cover fundamental mechanical and electrical engineering concepts, as well as industry specific topics and case studies. Attendance is expected at all on-line lectures and students should review materials pre-and post and ask questions. Good term projects have often resulted in published papers and sometimes real products, which is a huge boost to one's resume!

Course e-mail lists

Students agree that these e-mail lists will be strictly limited to course use only.

2.75-2020@mit.edu Contacts the entire course students and staff
2.75-staff@mit.edu Contacts the course teaching staff

Teams are asked to create their own internal e-mail lists, with or without their project sponsor, and post them to the Wiki.

Team Term Project

The goal of the project is to follow a deterministic design process (by remote connection or with socially distanced meetings of students are on campus and need/can meet to evolve designs and make porotypes) to rapidly and efficiently develop a proof-of-concept prototype device that addresses a real need. As COVID-19 conditions allow, prototypes are evaluated, demonstrated during the final on-line presentations and documented in a journal format written paper.

Students will work in small 4 – 5 person teams to execute a substantial, health-focused project, which spans the entire term. Potential projects are presented by clinicians and companies in the second week of term and students are asked to *individually* rank their preferences, considering where they can contribute the most. Teams are then formed by the staff, based on student preference and skills. Given the wide array of student interests and expertise, there have been few past difficulties in satisfying everyone.

As COVID-19 requires as much work to be done as possible remotely, it creates an opportunity for students to learn how to do product development in today's distributed world where, for example, team members in City A work with team members in City B.

Please understand that given the project-clinician/proposer relationship, small teams and aggressive schedule, signing up for a project constitutes an implicit agreement NOT to drop the class.

Project mentors have committed to being accessible, are ready to engage with you on a regular basis and will truly be part of your team!

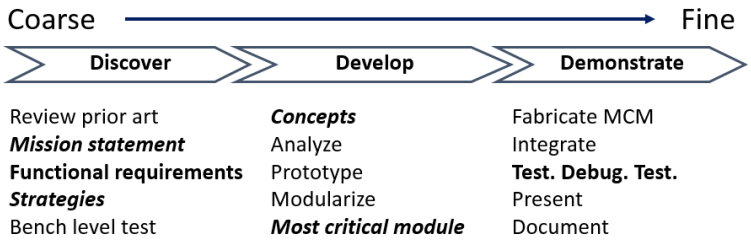
To help maintain a fair pace, consistent with the units for the class, tasks for each person to complete before the next meeting will be set each week and recorded on the team wiki. At the next meeting, progress made by each team member will be recorded by the team mentor. This will help all members stay focused, ensure work balance between team members, and help achieve grading fairness.

Note: Because full participation in the project is integral to the class, listeners cannot be accommodated. Students CANNOT take 2.75 and another major lab/product development class (e.g., 2.009) in the same semester, nor a class that overlaps time wise.

Together over 9 weeks of this shortened semester, teams will follow a deterministic design process which fosters creativity inspired/guided by analysis but eschews shoot-from-the-hip design (this is NOT a hackathon class.) The project process is roughly broken up into thirds:

1. Discover – Problem presentation by client, team formation, detailed problem understanding, investigation of prior art, definition of functional requirements and exploration of possible solution *strategies*.
2. Develop – With a specific *strategy* selected, specific *concepts* are developed, analyzed and tested. The design is divided into modules and attention focused on the *most critical*.

3. Demonstrate – The entire system is fabricated, integrated and tested. Proper documentation is an important, oft shortchanged, step that begins the *design history file that documents the design's development*, essential for any quality product (e.g., ISO 9000) and especially for medical products (FDA requirements).



Three phase, 14 week deterministic design process

Throughout the deterministic process, all decisions must be backed up by appropriate analysis, experiments, and PREP – *Peer Review Evaluation Process*, where each team member keeps a detailed design notebook (digital or on paper at home they then scan and post so can be shared via screen in zoom mtgs) and peers review each other's work. In the event that IP results, inventorship must be corroborated by individuals' notebook entries.

Failure is defined as a non-working prototype (if can be built this semester, else "paper design") and no idea why it failed. Failure is *NOT* defined as a prototype that functions, but conclusively demonstrates that a concept will not meet clinical requirements. The former is lack-of-focus and the latter is research.

Teams are expected to meet online every week with their project mentor, at a mutually convenient time.

Weekly Team Mentor Meetings

Each team will be assigned two course staff mentors who will meet with teams and the project mentor weekly to review progress, brainstorm/solve project design problems and locate resources. In order to maximize productivity and minimize frustration, it is critical (and good professional practice) for each team to meet before the mentor meeting, *peer review* their ideas and prepare an agenda that addresses three key questions:

1. What did you do last week?
2. What will you do this coming week?
3. What resources do you need?

In the context of questions 1 and 2, every week one or more overall project milestones will be due. We will require students on Canvas to evaluate how well they achieve their milestones as well as their teammates' milestones. This will help us keep each other accountable and to set realistic goals.

At the end of each mentor meeting teams and mentors, together, will identify and assign the action items for the next week. Holding each other responsible is key to a fair distribution of workload among team members and across the semester. Yes, mentors can get action items too!

Each team member is required to maintain individual notes and teams must also take weekly notes and post them the Wiki.

Bottom line, the better prepared a team, the more the mentors can help the team achieve a successful and satisfying conclusion!

Please note that Prof. Slocum's wife's medical status requires he cannot risk attending meetings in person. He will thus be participating remotely. He has a good shop in his basement that he can make models to show as examples as needed to help with mentoring teams.

Teamwork

Teamwork is central to functioning of this class and any modern engineering endeavor and it is expected that students will work together in a *safe, professional, and collegial manner* as defined in MIT's policies and procedures, especially 9.0 "Relations and Responsibilities Within the MIT Community," http://web.mit.edu/policies/9/.

During the first weeks of teamwork, please identify any perceived problems with your team's dynamics promptly, and bring them to the attention of your team members and/or course staff, who will help resolve issues. This is important in the professional world where there are no "safe spaces" and issues must be addressed politely and proactively. We can help make 1/☹ = ☺.

Peer Evaluations & Midterm Review

In addition to the weekly checks, just before midterm, an anonymous peer review will be conducted using the CATME tool, developed at Purdue. The results will be reviewed by the course staff who will intervene as needed to help improve team performance. Grades, as an indicator of performance thus far, will be provided to each student along with constructive feedback. Consider this a performance review – it does not define your final grade but can help with focus and direction if needed.

At the end of the course, team members will again review each other and the combined ratings can be used to adjust individual grades by up to a full letter. To be clear, the focus is on professional performance, not popularity.

Quizzes

Normally, 2.75 has a short 5 – 10 minute quiz at the beginning of each lecture based on the pre-reading or the previous lecture's content. This year these quizzes will be implemented in Canvas outside lecture hours, with short time limits. These are designed to reinforce the lectures, as well as provide important feedback to the instructors. They should not cause undue stress and the two lowest quizzes will be dropped.

Labs

At the onset of the course there will be two lab assignments:

1. Design, build, and test a kinematic coupling (KC) which demonstrates the principles of exact constraint design, important for any mechanical device.
2. Design, build, and test a simple, non-invasive electronic heart monitor - the ECG, which uses electrodes and circuitry, to detect and report heart rate.

The objective of both labs is to help familiarize students with knowledge, tools, equipment, and hands-on skills needed for R&D in the field of medical devices.

The kits provided to students can be safely used at home, so no special lab space is required, nor can it be provided at MIT.

Although materials for the two lab assignments will be provided, though students are welcome to use their own supplies and be creative! Because good design demands a process (measure twice, cut once) the labs will be completed in two parts: First a written proposal with engineering drawings must be submitted, and then following build and test, a brief lab report and on-line demonstration, posted to Canvas. Both can also be posted on your personal websites, and in the past, they have had a very positive impact on student's ability to get the good job they were hoping for. Accordingly, labs will count as substantial portion of the course grade.

Prototyping & Budget

Each team will have a budget of about $2,000 (exclusive of MIT overhead) to develop, prototype, and test their solution. Legitimate expenses include components, machine shop services (must get an estimate for cost of job), local travel (mileage, taxi…), etc. You cannot charge food under any circumstances.

Your mentor will guide you in efficient use of your budget. Remember, your time has value, thus there is a tradeoff between your fabricating (which will be difficult as parts need to be secured on-line but extreme care must be exercised because the budget can be rapidly depleted with on-line services) and sourcing outside components. Remember the three D's: Deliverables – Deadlines – Dollars!

Irina Gaziyeva will administer team accounts and oversee purchasing procedures and guidelines. Students will be asked to use standard class ordering procedures and are *required to provide all order confirmations and packing slips to Irina Gaziyeva*. Please appoint a single person to manage the budget and coordinate with Irina. Teams are required to track their expenses on their Wiki. If Irina is missing a receipt from a team, the team will be missing a final grade at the end of the semester! So whenever an order is placed, c.c. Irina with the team name. Whenever a receipt is obtained, cc Irina or write on it team name, scan it, and email it to her.

If you buy something local you need to use the MIT tax exempt number, as you cannot be reimbursed for sales expenses. Any purchasing questions, ask Irina! This is an MIT requirement for audit purposes. *No packing slip, no grade!*

The course staff has many contacts with helpful vendors that are able to accommodate the needs of prototype projects (the cheapest vendor is not always the best …) and we are happy to have new suggestions. When in doubt, ask!

Fabrication Resources

There are no dedicated fabrication / lab spaces set aside for this course and since each project is different, staff will work individually with teams to ensure that they obtain the necessary resources. Teams are welcome to use any other lab / fabrication facilities that they have access to and permission to use and it is understood that this will be extremely difficult given the COVID-19 crises. Please consult MIT guidelines around accessing fabrication spaces.

Some available resources might include (students need to check to see if access available this Fall)

Mobius - Can help you locate and access some of the campus' 45 major maker spaces.

MIT Hobby Shop – Semester membership provided to students in 2.75. Safety training required.

EECS Lab (38-601, 38-530) – bench space, instruments, tools, and proto boards available by appointment only!

Edgerton Center Student Shop (44-023) – Open to all MIT students, safety and machine operation training required via a special course as required by the shop.

MakerWorks - LMP (35-122) – Restricted to Mechanical Engineering students, safety training required.

As part of our preparation and planning during COVID-19 Profs. Roche and Traverso will be offering multiple projects which will be co-mentored by members of their labs. As part of this teams will have the ability to work and use equipment under the guidance of their co-mentors. The Roche Lab is located in E25-331 and E25-538 and the Traverso Lab in room 5-029 and 5-008.

Teams are responsible for keeping all workspaces clear and returning equipment to the proper storage to avoid access revocation.

NOTE: BeaverWorks *cannot* be used for course 2.75 projects, since Lincoln Labs will claim ownership over any potential IP for anything anyone does at BeaverWorks. If you complicate the IP situation for your team, you will not receive a grade for the class until YOU fix it!

Teams looking for spur of the moment meeting locations are recommended to use the QuickRoom tool: https://classrooms.mit.edu/classrooms/#/quickroom

Note: Projects requiring cell / tissue / BL2 work should coordinate with the instructors to access approved spaces.

If there are any questions / doubts regarding fabrication or safety - ask the course staff immediately.

Documentation

Documentation is especially important to the medical device industry for the purposes of establishing a *design history file*, which is required for regulatory approval, establishing inventorship and building an IP portfolio.

Notebooks

Each student is expected to maintain a paper or digital design notebook with sketches, calculations, pictures, etc. that document their individual contributions, late night ideas and general project notes. These may be reviewed during mentor meetings and factor into grading. Instructors also keep notebooks, which they update during meetings and presentations and use them to help manage the teams and document their own contributions. *Notebooks document the design's development*, essential for any quality product (e.g., ISO 9000) and especially for medical products (FDA requirements).

Canvas

Canvas will be used for syllabus, lab materials, zoom links and recordings (where applicable), quizzes, surveys and class announcements.

Wiki

The course Wiki serves as a long-term project archive, independent of Google, Dropbox, etc. where each team must create and maintain their page. Weekly teams must document their progress of their project with notes from internal, project proposer and mentor meetings posted to the Wiki. Key design decisions, important milestones, decision matrices, images, papers, etc. should be posted to the Wiki. This Wiki is viewable by everyone in the class and instructors will use it to track team progress. You are encouraged to look at past projects for inspiration and organization!

All project deliverables are "turned in" by posting to the Wiki, including in-class and final presentations and written deliverables.

Intellectual Property

IP is sometimes generated in this course, and thus it is essential that all team members (clinicians and instructors included) keep bound, signed, dated and ideally witnessed design notebooks to record individual contributions. Not everyone will necessarily be an inventor, but the more engaged a team member is, the greater the likelihood that he or she will contribute specific features (claims) to the IP and, thus, be formally considered an inventor. Whether or not you are an inventor has no effect on your grade, because you can be a person who helps reduce an idea to practice and thus be a critical team member and journal paper author even though you might not in the legal sense be an inventor. IP and any royalties (this is an extremely rare occurrence) will be shared amongst the inventors and their institutions. IP created by students in an MIT course is considered property of the students, however, the inventors may decide it is best for it to be assigned to the MIT Technology Licensing Office for prosecution. If a staff member is an inventor, then MIT policy states that the IP belongs to MIT and inventors share any future royalties in accordance with MIT TLO policy. NOTE "getting a patent" is expensive and useless unless team members are dedicated to on their own time following up development of the idea. It is exceedingly rare that an idea worked on for a single semester is ever simply adopted by a company and turned into a product. It is far more valuable in general for a team to do a great project and then publish a peer reviewed article on how the idea was developed, and then maybe one day it is picked up and built on (and referenced). The MIT Emergency Ventilator Projectv began with a 2.75 project from 2010.

Communication

This is a communication-intensive course where all students are required to communicate as professionals, both in writing and during on-line presentations and design reviews. For undergrads this fulfills the CI-M requirement and can be used in place of 2.009. For graduate students the communication requirements are an important part of professional development.

The communication requirements are fulfilled in the context of each team's project and include:

- Weekly peer review of each other's work in design review meetings (with the instructors).
- In-class (online) strategy presentation
- In-class (online) concept presentation
- In-class (online) *most critical module* review
- Final presentation (online)
- Final paper & one-page project description.

Further details and presentation guidance will be provided during the term.

Final Paper

Each team will write a journal format, publication-quality, final paper. This must follow the guidelines of an established journal, i.e. the ASME Journal of Medical Devices, ASME Journal of Mechanical Design or IEEE Transactions on Biomedical Engineering. As you conduct background research for your project, you will encounter many good examples of "A" papers.

This add structure, facilitates brevity and has enabled many past teams to successfully submit their work for publication!

Write early and write often: It is critical to write as-you-go to prevent last minute panic, i.e. but the end of September every team will be able to write their background section. Therefore, ideally by the end of the term only editing will remain. Teams will also write a 1-page executive summary.

By the end of the course, we expect every student to become comfortable talking about their work and, effectively, be ready to give a podium presentation at a conference. The communication instructors are resources to help each team and individual to develop their communication skills; please reach out as needed.

Recommended Texts

1. FUNdaMENTALS of Design, A.H. Slocum, posted to the course website. This is a MUST download and read (as well as the design spreadsheets). Carefully reading and comprehending this design knowledge will lead the greatly enhanced design happiness in the class and in your professional design career.
2. Precision Machine Design, A.H. Slocum, for the serious deep thought machine designer. Copies are available from Irina at the author price.
3. "Fundamentals of Electronics" Lectures, posted on course Wiki.
4. "The Art of Electronics 3rd Edition", Horowitz and Hill, Cambridge University Press.

Grading

This is an advanced design course for students who are ready to step up to act as professional engineers! Therefore, as in industry, we will not be giving detailed weekly grade feedback nor a detailed midterm expected grade. We will conduct a mid-term review

and often assign project action items to individuals. Together, these should provide a good sense of your progress and instructors are available to provide feedback as needed.

Work hard and efficiently and you will do great! Remember — the grade is not nearly as important as learning a design process and developing a prototype and documenting what YOU did with the team to bring it to life, so you can be proud and show your work to potential employers. Many past 2.75 students have told us that it was going over their design notebook or their website with an interviewer that led to their good job.

The course grade is based on: A = 90-100; B = 80-90; C = 70-80

Term Project – Team Grade Execution of the design process Meeting scheduled milestones Use of time and $ Quality of design & execution (details & execution)	40%
Individual Performance Contributions to project (monitored via weekly check offs) Use of lab notebook (on-line or scan and post on Wiki) PREP (peer review) effectiveness Participation in class presentation Q&A Communication intensive meetings	10%
Formal Communications Team Presentations Final Paper	20%
Peer weekly assessment of team members	10%
Individual EKG lab & KC Labs	20%
Total:	**100%**

Post semester, should there be any grade concerns, students must present their design notebook for review, be prepared to discuss any of the materials covered in the class and then accept that their grade may go up or down.

Student Disability Services:

MIT values an inclusive environment. If you need a disability accommodation to access this course, please communicate with us (the faculty/teaching staff) early in the semester. If you have your accommodation letter, please meet with the faculty so that we can understand your needs and implement your approved accommodations. If you have not yet been approved for accommodations, please contact Student Disability Services at uaap-sds@mit.edu to learn about their procedures. We encourage you to do so early in the term to allow sufficient time for implementation of services/accommodations that you may need.

Student Support Services*: If you are worried that you are about to (or do) fall behind…*

If you are dealing with a personal or medical issue that is impacting your ability to attend class or complete work, please discuss this with Student Support Services (S3). The deans in S3 will verify your situation, and then discuss with you how to address the missed work. Students will not be excused from coursework without verification from Student Support Services. You may consult with Student Support Services in 5-104 or at 617-253-4861.

Graduate Students: Please reach out to the deans for personal support in the Office of the Dean for Graduate Education.

Other Concerns

If you have significant travel or personal needs that you believe may impact your ability to work effectively in a fast-paced team, this may not be a good course choice, please discuss your concerns with a member of the course staff.

We are committed to making this a positive learning experience for all of us, so please come and talk to us.

Schedule

Please note that the schedule may be modified as circumstances demand during the course of the term.

Wk #	**Start Date (Mon)**	**Monday On-Line Lecture** 13:00-14:30 EST Staff available 1:30 – 15:00	**Optional Monday On-Line Lab / Help Session** 15:00-17:00 EST	**Wednesday on-line Lecture** 13:00-14:30 EST	Weekly Tasks & Milestones
1	8/31	No Class	No Lab	• Welcome, Course Introduction (Alex & Nevan) • Review of projects available • Questions	• Install Solid Modelling program (e.g., Solid Works or Fusion360) and practice • Indicate project selection • Topics 1, 2, 3 of FUNdaMENTALS to be read before 9/7 • **Complete project selection survey by Friday 12:00 EST** • ***As soon as you select your project we will ship your lab kit*** • Lab kits will be sent to all confirmed students
2	9/7	• **Labor Day Holiday**	No Lab	• FUNdaMENTALS Topic 1, 2, 3 (Alex) • Communications (Dave & Mary) • Lit and patent search (Courtney Crummett, MIT Libraries, crummett@mit.edu) – recorded	• Teams Announced (e-mail by Monday) and schedule meeting with project proposer • Teams contact mentors and schedule weekly meeting online ASAP • Topics 8, 9 of FUNdaMENTALS to be read before 9/14 • Begin to research prior art including products, literature and patents • Document literature and prior art search findings (include references) on Wiki • Identify functional requirements • Begin to research strategy options • Start to fill out (FRDPARRC) • Team Wikis functional by Friday
3	9/14	• Electronics for Medical (Gim) • ECG Lab Review (Gim & Cecile) • Mission Statements (Nevan)	• Unpack and go through mechanical kit. Emphasis on the KC parts and what can do with them to enable students to create a KC Proposal for a design they will build and test.	• FUNdaMENTALS Topics 8 & 9 (Alex) • Communications (Dave) • Precision design: Structures (Alex)	• Team Mission statement due by Wednesday • Strategies formulated • Top 3 strategies selected, and described with FRDPARRC table(s) ready for presentation

4	9/21	• **Teams' Strategy Presentations** (begin with your mission statement)	• Unpack and go through electronics kit. • Questions on KC hardware or testing? • Macramé lesson (Debie) • Sketch model techniques for project design development	• **Teams' Strategy Presentations** (begin with your mission statement)	• <u>KC Proposal Due Monday</u> • One "best" strategy selected for detailed development post presentations • Topics 4, 6, 8 of FUNdaMENTALS to be read before 9/28 • ECG Part 1 finished and documented by Friday
5	9/28	• FUNdaMENTALS Topics 4, 6, 8 (Alex) • Kit mechanical elements for linear motion	• ECG lab development Q&A	• Electronics for Medical (Gim) • Complete Peer Evaluation	• Kinematic couplings finished, tested, and documented on Friday • Topics 5, 7 of FUNdaMENTALS to be read before 9/14 • Sketch models and bench level experiments to develop concepts • Paper Introduction due
6	10/5	• FUNdaMENTALS Topics 5, 7 (Alex) • Case Study Design of insulin injection pens (Alex)	• Students present their KC designs in sessions with their mentors (parallel lab sections Zoom rooms)	• Case study: MIT Emergency ventilator (E-Vent team)	• ECG Part 2 finished, tested, and documented • Further develop concepts and experiments • Top 3 Concepts selected, and described with their FRDPARRC tables completed • Create detailed schedule to completion • Draft of *background* section of 2.75 final paper/journal article • Peer Evaluation #1 completed by end of week
7	10/12	• **Holiday: Columbus / Indigenous People Day**	• **Monday Schedule** • **Teams' Concept Presentations**	• **Teams' Concept Presentations**	• Draft of *design/methods* section of 2.75 final paper/journal article; the *methods* draft can be in the form of a testing proposal
8	10/19	• Concept Presentations feedback • The mask of Gio! (4.5 stars) • FUNdaMENTALS recap	• Sketch models and Bench Level Experiment techniques (use elements from kit) • Macramé questions and show and tell (Debie	• Design process, materials mechanics lessons from cardiac health and case studies (Ellen)	• Best concept selection, and good sketch model done and tested so as to enable "real parts" to be made • Most Critical Module (MCM) engineering begun • Paper Background due
9	10/26	• Transforming the pill: from daily to weekly/monthly dosing (Gio)	• Lab to answer student questions	• The Beating Heart: Models and test methods (Ellen)	• Send parts out for fabrication! (later and they will not arrive on time) • Manufacture test parts for MCM
10	11/2	• **Rapid Reviews** (teams present their progress and class as a whole to help answer questions)	• Lab to answer student questions about concept development	• Models for evaluation of your biomedical invention: from cadavers to pigs (Gio) • Q&A solve bugs, final mfg, integration and test	• Most Critical Module (MCM) complete • Begin engineering of other modules • Finish manufacturing of MCM parts

11	11/09	• Adventures in MedTech - Aidan Petrie, NEMIC	• Develop final presentations (Dave)	• **Veterans Day – Holiday**	• Engineering for other modules complete • Final manufacturing in process • Paper Methods due
12	11/16	• Who will pay for it? - Charles Mathews, ClearView Healthcare Partners	• Staff arrange meetings with student teams	• Intellectual Property - Ben Rockney, MIT TLO) • Regulatory Considerations - Adam Jacobs, Sunrise Labs	• Final manufacturing & integration complete • Testing complete and documented, tweaked & ready to present • Draft of PowerPoint slide deck • Final paper outline
13	11/23	• No Class	• No lab	• **Happy Thanksgiving!**	• Relax • Seniors – safe travels home!
14	11/30	• More Adventures in MedTech - Aparna Bhave & Catherine Condie, Boston Scientific	• No official lab, but staff will be online to answer questions.	• Portal Case Study, Bobby Dyer	• Final paper draft complete • Final presentation ready in PDF and PowerPoint
15	12/7	• Final Presentations (online)	• Macramé showcase! Students show their creations!	• Final Presentations (online) • Complete course evaluations	• **Final Deliverables Uploaded to Wiki, by Monday December 14** • Paper following a known Journal format in PDF and Word • One-page concise description in PDF and Word • Any video media that you may have created • Complete Peer Evaluation #2 • Final Wiki updated with deliverables for archival purposes