BE 478: Engineering approaches for refugee health
665 Comm Ave (CDS) Room 262
Tue/Thu 3:30-5:15 pm
Professor Muhammad Zaman (zaman@bu.edu)
Office hours : by appointment
Teaching Fellow: Fereshteh Jafarbeglou (Fbeglou@bu.edu)

Introduction and context.
Globally over a hundred million persons are displaced due to conflict, persecution, economic collapse and climate change. Some are displaced in other countries (refugees), others are forced to flee within their own (internally displaced persons) and while some others are denied the basic right of citizenship (stateless communities) by states. Given recent conflicts in many parts of the world, these numbers are likely to increase significantly. Forcibly displaced communities often live in precarious conditions that are characterized by conflict, poor housing structures, hazardous environment and lethal infectious agents. These factors, combined with poverty, exclusion, xenophobia and racism, further increase the risks to life, health and well-being of forcibly displaced communities. The health challenges faced by these communities are complex and multi-faceted, and require not only a broader understanding of the drivers of forced displacement, but also an analysis of technological solutions for disease diagnosis, treatment and management. Unfortunately, few efforts have been made to systematically and rigorously analyze the landscape of technological solutions to improve health of forcibly displaced communities.

This course is an effort to develop a holistic understanding of health of vulnerable, forcibly displaced persons, understand the drivers of displacement, appreciate the contextual realities, develop knowledge of mathematical models to evaluate the risk of disease or burden of infection, critically analyze existing technological solutions from a technical and ethical lens, and design interventions to improve health of these communities. In addition, this course will provide students with an opportunity to interact with experts who bring diverse perspectives informed by lived experiences, community engagement and policy design and intervention. In addition to mathematical modeling, device design and technical analysis, the students will also get an opportunity to discuss their perspective, analysis and findings through writing for a broad general audience.

Attendance: In person attendance is mandatory. For lectures that may be on zoom, attendance with a camera turned on is required.
Tardiness: Being punctual is expected, and frequent episodes of tardiness may result in a grade penalty.
Policy on generative AI: Use of generative AI software of any kind, for any assignment, is strictly prohibited. Generative AI usage without prior instructor permission would be considered academic misconduct and will be dealt in accordance with BU's policy on academic misconduct.

Policy on inclusion: The goal of the course is to learn, engage and understand – but we will do so in a way that is most respectful and inclusive. We want to ensure that every single student feels welcomed and is able to participate freely in a respectful manner at all times.

Accommodations/Resources/Support

Students needing academic accommodations are strongly encouraged to contact the Office for Disability Services (353-3658).
Office of Disability Services
19 Deerfield Street, 2nd Floor
(617) 353-3658
http://www.bu.edu/disability/

Educational Resource Center
One-on-one peer tutoring, study skills help, and writing assistance.
100 Bay State Road, 5th Floor
(617) 353-7077
www.bu.edu/erc

Behavioral and Mental Health: Nearly two thirds of BU students say that their mental health struggles have impacted their academic performance. The course material and the topics covered (e.g. violence, exclusion, persecution) may be challenging for some students. I would strongly encourage to reach out to me if you find yourself struggling with the topics. In addition, there are other campus resources available to navigate issues around behavioral and mental health including:

- Behavioral Medicine (617) 353-3569
- Center for Psychiatric Rehabilitation (617) 353-3549
- The Danielsen Institute (617) 353 – 3047
- SARP (617) 353 – 7277
- 24/7 on-call service for mental health emergencies (617) 353-3569

Knowledge, Abilities and Skills Students Should have entering this Course: mathematics through differential equations.

Knowledge, Abilities and Skills Students Should Gain from this Course: an understanding of the health challenges faced by forcibly displaced communities, current biomedical technologies and solutions used to address these health challenges, and a project based approach to identify and develop novel, technically sound, context-appropriate, sustainable and ethical solutions. Furthermore the course will focus on development/refinement of effective general engineering problem definition and solving skills leading to adaptive expertise. We will also focus on ethical approaches to engineering problem solving and applications in complex environments. Finally, in addition to technical design and analysis of existing technologies, the students will get an opportunity to share their work through writing for a broad general audience.

Attendance: required for all class periods. The course is designed for much of the learning experience to occur during the class period.

Student Feedback*:* I take teaching very seriously, and want to constantly improve and want to address problems students may be having during class. Therefore in addition to the mid-term and end of term class evaluations, we will have a number of "anonymous" evaluations routinely in class. The students will be given an opportunity to raise any concerns they may have about the course teaching and other course related issues. I will try my best to address these issues.

Class Structure: The class will have both lectures and team-based project activities. Students will be randomly divided into groups of 4-5 students and will work with their teams throughout the semester. There will be four homework assignments and two presentations. The class does not have any quizzes or exams.

Academic Honesty: I am assuming we all will uphold the highest standards of academic honesty. The class will be highly interactive, and hopefully a lot of fun. However, any kind of academic dishonesty in an exam will not be tolerated and severe disciplinary action will be taken.

Course Assignments, Readings and Announcements: will be posted on the course website. Problem sets will be typically due once every three weeks in the first half of the course. The second half will not have any problem sets.

Grade distribution.
Homework : 20% (5% each)
Presentation 1: 8%
Technical Report 1: 12%
Broad audience writing assignments : 10% (5% public writing 1; 5% public writing 2)
Final project presentation: 12%
Final project writeup: 23%
Class participation: 15%

Course schedule

Date	Topic	Focus	Readings	Other notes
1/21 *	*Introduction & "Big"* Data	Why this course? And why now? What is forced displacement and why does it matter? What is the global data about forced displacement? Is that data reliable? What are the sources of error? Who gets counted, and who does not? Where do most refugees live?	Zaman. We Wait for a Miracle; Johns Hopkins Press, 2023. Pages 24-35. UNHCR data portal https://data.unhcr.org	Survey 1 due; The lecture will be on zoom from the Lancet Commission where Professor Zaman will discuss the stubborn challenges in humanitarian efforts and some new ideas. For more details see: https://www.google.com/search?client=safari&rls=en&q=chh+lancet+commission+on+health+conflict+and+displacement&ie=UTF-8&oe=UTF-8
1/23	Why do people move?	Historical trends and projections. The challenges and opportunities in quantification of forced displacement. Case studies and local context. What does the past data say about the future?	Zaman. We Wait for a Miracle; Johns Hopkins Press, 2023. Pages 46-62 https://earthtime.org/stories/global_refugee_crisis_the_big_picture Forgotten Refugees (Nation 2017); https://www.thenation.com/article/archive/the-forgotten-refugees/ Talk of an 'unprecedented' number of refugees is wrong – and dangerous Benjamin Thomas White, New Humanitarian https://www.thenewhumanitarian.org/opinion/2019/10/03/unprecedented-number-refugees-wrong-dangerous	
1/28	The lived experience	Recording of interview with John Thon Majok. Director of Refugee and Forced Displacement Initiative. Wilson Center https://www.wilsoncenter.org/RAFDI	What is a refugee camp for? Robson https://www.currentaffairs.org/2020/01/what-are-refugee-camps-for	Student & TF discussion on HW in class.
1/30 *	Health, healthcare and the forcibly displaced	Trends in infectious diseases; Mechanisms and drivers of disease ; The disproportionate impact of displacement on women's health. Technical barriers in diagnosis of disease.	Infectious diseases in refugee camps and stateless communities. https://www.joghr.org/article/12009-infectious-disease-epidemics-in-refugee-camps-a-retrospective-analysis-of-unhcr-data-2009-2017	HW 1 due on UNHCR data visualization and gaps in data. Lecture on zoom from the field in Pakistan on statelessness and infectious diseases.

		The importance of understanding the context.	One Health Approach https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10332798/ Health impacts of a refugee crisis: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6297302/	
2/4	Can we model the next outbreak?	Mathematical models of disease dynamics (SIR, ODE and other models) and their limitations.	SIR model of infection: https://maa.org/press/periodicals/loci/joma/the-sir-model-for-spread-of-disease-the-differential-equation-model	
2/6	Do the models work? Error estimation and improvement in predictions	1. Discussion with Dr. Daniel Parker, UCI and MSF https://publichealth.uci.edu/faculty/parker-daniel/ 2. Testing and validating models	Limitations of existing models https://jamanetwork.com/journals/jama/fullarticle/2766672 Non-communicable diseases among forcibly displaced. Zaman et al, We Wait for a Miracle Chapter 4	HW 2 on SIR models due. Class discussion : what did we learn from the models?
2/11	Engineering a solution	1. What can engineers do? Which solutions have worked and which ones have not? Analysis of barriers to technology design, piloting and implementation. Who are we designing for? Technical assessment of solutions vs ethical assessment of solutions	Nadkarni et al, https://conflictandhealth.biomedcentral.com/articles/10.1186/s13031-017-0122-0 Video: https://vimeo.com/261862125 https://journals.sagepub.com/doi/10.1177/2056305119863146	
2/13	Analysis of engineering solutions	Development of field-ready diagnostics and their applications. Foundations of FMEA analysis	FMEA. The cure for Medical Errors. https://www.stat.purdue.edu/~kuczek/stat513/Relevant%20Articles/Relevant%20Articles/FMEA%20medical.pdf Hands on exercise to evaluate failure modes.	
2/18	Privacy, technology and the vulnerable groups	Discussion with BU Professor on privacy and technology.	When 'Do No Harm' Is Not Enough: The Ethics of Research with Refugees and Other Vulnerable Groups https://www.jstor.org/stable/43771515 Deconstructing the White Savior Model through Engineers Without Borders student chapters: an unlikely intervention https://peer.asee.org/deconstructing-the-white-savior-model-through-engineers-without-borders-student-chapters-an-unlikely-intervention	HW 3 due on failure modes analysis; Design teams assigned

2/20	Thinking large and small	What is a health system, and how does it work in a refugee camp? What about communities that are not in camps? Are we biased in our analysis and assessment? Gender issues and forced displacement. Mathematical and contextual analysis of disease outbreaks in urban slums (South Africa) and a health-systems perspective in a conflict setting (Yemen)	Health System in Low and Middle Income Countries: https://www.oecd-ilibrary.org/sites/5a3b7d49-en/index.html?itemId=/content/component/5a3b7d49-en UNHCR : Health System in a Camp https://emergency.unhcr.org/emergency-assistance/health-and-nutrition/health-care-contexts/health-camps	
2/25	Design of interventions within a system	Modeling of a health system; Introductions, assumptions and workings of Markov Chains; data analysis and predictive modeling with data of varying quality	A predictive model for healthcare coverage in Yemen. https://conflictandhealth.biomedcentral.com/articles/10.1186/s13031-020-00300-1	
2/27	The state and the system of exclusion. What about the stateless communities?	Discussion with Tahera Hasan, Director, Imkaan Welfare, Pakistan. https://imkaan.org	Statelessness and healthcare https://statelessnessandcitizenshipreview.com/index.php/journal/article/view/357	HW 4 due on modeling of a health system in outbreak
3/4	Communicating with a broad audience; Design exercise 1 begins	1. What can be done to improve the design of an existing solution. What are the costs to improvement vs redesign? Financial, technical and ethical considerations. 2. Communicating your results to a broad audience.	The fallacies of a "typical user" idea https://www.wired.com/story/technology-design-marginalized-communities/ Yes, digital IDs are efficient. But they're a threat to our very identities https://thecorrespondent.com/217/yes-digital-ids-are-efficient-but-theyre-a-threat-to-our-very-identities How to write an op-ed? https://www.theopedproject.org/resources	
3/6	Design Exercise 1 continues	What can be done to improve the design of an existing solution (contd.)	Designing devices for vulnerable populations https://www.embs.org/pulse/articles/designing-devices-for-vulnerable-populations-what-needs-to-change/	
	Spring Break			
3/18	Presentation on design exercise 1	½ of the groups will present		Op-Ed 1 due
3/20	Presentation on design exercise 1	½ of the groups will present		

3/25	Class discussion on design	What have we learned so far? The ethics of design. Refugee health and the international human rights framework Discussion with a BU philosopher	Who benefits? https://link.springer.com/chapter/10.1007/978-3-031-12350-4_23 https://www.protocol.com/policy/refugees-iris-scan-privacy-jordan	Design exercise report due
3/27	Solution design part 2	What is the goal? What "problem" are we solving?	Stanford Biodesign Resources https://ebiodesign.org	Lecture takes ~20% of the time. Students work in teams
4/1	Design contd. Key parameters of design	How do we know what is a "good design". What is acceptable error? What materials should we use?	Slides will be uploaded to course website	
4/3	Design contd. Cost estimation and business models	What does sustainability mean in a complex environment? How do we quantify success? What are the sources of funding and why would they fund?	Slides will be uploaded to course website	
4/8	Attend CFD Conference	CFD Conference		
4/10	Design contd. Technical review part	Analysis of realistic scenarios. Simulation of use cases and fitting within the health system.	Slides will be uploaded to course website	
4/15	Design contd. Focusing on the implementation plan		Slides will be uploaded to course website	
4/17	The hype versus actual promise. What can tech do for refugee health?	Case studies on emergent tech in humanitarian space. The need for regulatory and ethical frameworks in developing technology. The challenges in structural barriers in tech development and adoption.	Case studies on AI / Digital Tech in humanitarian settings and in class discussion	
4/22	Final Presentations part 1			
4/24	Final Presentations part 2			
4/29	Looking back, looking forward	The role of engineers in addressing complex health challenges faced by forcibly displaced communities. What have we learned this term, and how do we move forward?		Final design manual and report due