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Data-driven Thinking, Modeling, and Statistical Inference for Global Health Challenges

Overview

The post COVID-19 pandemic era has seen significant advances in health data collection and analysis, bolstered by the wider availability of medicines, vaccines and medical procedures that have collectively reduced the burden of infectious disease, improved health outcomes, and extended longevity globally. Despite these advancements, several global health challenges are likely to persist and expand, in part because of population growth, urbanization, and antimicrobial resistance, where changing model thinking, and novel data analytical techniques can assist dramatically in managing future health challenges.

This course is designed to expose participants to how data-analytical thinking is transforming the field of quantitative global health. It equips students with the latest in model thinking and data analytics through novel modeling approaches and innovative pedagogical tools, all while exploring cutting-edge techniques in modern infectious disease epidemiology. Emphasizing the critical need for a truly interdisciplinary approach, the curriculum combines diverse analytical and pedagogical methods to study the ecology, transmission, and control of infectious diseases.

The use of real-world data will serve as a foundation for all lectures, starting with real-life challenges and demonstrating each stage of the concepts alongside corresponding real-world data. Students will be introduced to a broad spectrum of theoretical topics and modern applied data-driven analytical methods, relevant to understanding and investigating the population biology, epidemiology, and control of diseases. Topics covered will include disease transmission modeling, health burden estimation, spatial ecology, host immunity, parasite ecology, socio-epidemiology of infection, intervention modeling, and health economics and management. Moreover, the integration of AI and ML tools into the curriculum will expose students to both the challenges and opportunities of applying these technologies in new and evolving contexts, fostering a critical understanding of their application in disease modeling and control.

Objectives

- Appreciation of the burden and impact of global health challenges including spread and control of infectious diseases on human populations.
- Gain fundamental understanding of modern theories of transmission dynamics, parasite life cycle, socio-ecological system, statistical epidemiology and design, health economics, spatial epidemiology, data synthesis, and intervention design and management.
- Capacity to use modern methods for investigating infectious disease epidemiology, including introduction to transmission dynamics modeling, estimation of epidemiological and public health metrics, spatial analysis, economic evaluation, and decision analysis.
- Capability to develop and apply inter-disciplinary approaches to investigating and intervening against major categories of public health issues and infectious diseases.
- Training in professional writing, reviewing, and presentation of scientific materials.

Exposure to cutting edge software and programs (Excel-VBA, Maple, RStudio, Open FOAM, MATLAB, & NetLogo) that may help in preparing participants for future jobs.

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Dates	**Course Duration** : **July 04 – July 8, 2025** (10 hrs. lectures and 10 hrs. Tutorials) **Date of Examination** : **July 9, 2025**	
Course Schedule	**04th July 2025**	**Lecture 1**: 1 hr - **AM** ○ Training in communication skills, both verbal and written. ○ Guidance on writing professional scientific documents. ○ Techniques for performing systematic literature review and citing sources. ○ Strategies for reviewing published articles and evaluating grey literature. ○ Instructions on preparing professional materials and presenting technical contents. **Lecture 2**: 1 hr - **AM** ○ Transformations of functions. ○ Historical perspective of mathematical disease models. ○ Foundation of data-driven infectious diseases modeling. ○ Epidemiological terminology for generating epidemic models. **Tutorial I**: 2 hrs - **AM** ○ Introduction to Modeling via ***Excel and Visual Basic Analysis (VBA).*** ○ Modeling and simulation of differential equations in ***Excel.***
	05th July 2025	**Lecture 3**: 1 hr - **AM** ○ Concepts of equilibrium stability analysis. ○ Computation of Reproduction number (R_0) using next generation method. **Lecture 4**: 1 hr - **AM** ○ Types of reproduction numbers and vectorial capacity. ○ Methods of estimating R_0. **Tutorial II**: 2 hrs - **AM** ○ Introduction to ***Maple.*** ○ Symbolic problem-solving for computation of R_0. ○ Estimating R_0.
	06th July 2025	**Lecture 5:** 1 hr - **DT** ○ Classification of viruses and bacteria and possibilities of disease recurrence. ○ Elimination goals of infectious diseases and global health challenges. **Lecture 6:** 1 hr - **AM** ○ Exploratory data analysis ○ Statistical analysis via regression models.

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		Tutorial III: 2 hrs - **AM** ○ Introduction in ***R*** and ***RStudio*** ○ Economics of Interventions and health economics models ○ Cost-effectiveness analysis and value of information
	07th July 2025	**Lecture 7:** 1 hr - **AM** ○ Disease immunology and human interventions models **Lecture 8:** 1 hr - **DT** ○ Modeling and Simulation of the virus propagation via physiological flows **Tutorial IV:** 2 hrs - **DT** ○ Introduction to ***OpenFOAM*** (CFD software) ○ Simulation of virus propagation in blood flow. ○ Bacteria movement in urine flow in OpenFOAM.
	08th July 2025	**Lecture 9:** 1 hr - **AM** ○ Modeling vector-related Interventions for vector-borne diseases. ○ Capturing underestimation and underreporting in data using mathematical models. **Lecture 10:** 1 hr - **AM** ○ Handling measurement errors ○ Model uncertainty analysis ○ AI and ML tools in disease modeling **Tutorial V:** 2 hrs: **AM** ○ Introduction to ***Matlab.*** ○ Parameter identifiability and under-ascertainment ○ Stochastic simulation models in ***Netlogo*** ○ Sensitivity and uncertainty analysis
Who can attend…	Student at all levels (BTech/MSc/MTech/PhD) or Faculty from reputed academic institutions and technical institutions are welcome to take the course.	
Registration & Course Fee	**Registration may be made by accessing the following online link:** **https://** **Following are the registration fees:** Faculty Members: ₹ 3000/- + 18% GST UG/PG Students: ₹ 1000/- + 18% GST Research Scholars/ Temporary staff of Research Project: ₹ 1000/- + 18% GST Industry Participants: ₹ 5000/- + 18% GST **Payment link:**	

International Expert:

Dr. Anuj Mubayi (AM) is Distinguished Fellow, Intercollegiate Biomathematics Alliance, Illinois State University (ISU), Normal, USA. He has completed his Ph.D. in Applied Mathematics in Life and Social Sciences in 2008 from Arizona State University, Tempe, USA, and his M.S. in Applied Mathematics with a focus on Fluid Dynamics from The University of Texas, Arlington, USA. He has extensive experience as a Health Decision Analyst and Mathematical Modeler, specializing in computational modeling, stochastic processes, and dynamical systems. His expertise spans health economics, epidemiology, and neglected tropical diseases, combining theoretical models with field data to understand disease transmission, uncover mechanisms, and develop effective therapeutic and control policies. He has published more than 50 papers in international journals, 05 edited Book, 03 book chapters and presented more than 10 papers in International Conferences. His research h-index is 21 and i-10 index is 44 and his papers have more than 2103 citations as per Google Scholar data base. He has been awarded the C Chavez Prize (2019) by Illinois State University and the IBA Junior Distinguished Fellow Award (2019). Additionally, he was nominated for the Zebulon Pearce Distinguished Teaching Award (2017-2018) and the Outstanding Doctoral Mentor Award (2018-2019) at Arizona State University.

Host Faculty:

Dr. Dharmendra Tripathi (DT) is working as Associate Professor in Department of Mathematics, National Institute of Technology, Uttarakhand. He has completed his PhD in Applied Mathematics (Mathematical Modelling of Physiological flows) in 2009 from Indian Institute of Technology BHU and MSc in Mathematics from Banaras Hindu University. His area of interests includes Biofluid mechanics, Peristaltic transport, Microfluidics-Nanofluidics, Newtonian fluids, and Nanofluids. He has supervised 08 PhD students and 05 are working under his supervision. He has published more than 220 papers in international journals, 03 edited Book in Springer, 02 edited Book in CRC, 10 book chapters and presented more than 40 papers in International and National Conferences. His research h-index is 59 and i-10 index is 190 and his papers have more than 9918 citations as per Google Scholar data base. He has been listed in top 2% researchers/scientist across the World as per Updated science-wide author databases of standardized citation indicators in every year since year 2020. He has received Best Faculty Award for year 2022 by NIT Uttarakhand, Best Researcher Award by ITSR in 2023, President Award in 2017 by the Manipal University Jaipur for outstanding contribution, Prof PR Sharma Memorial award from International Academy for Physical Sciences (IAPS) in 2021 and also become Associate Fellow of IAPS in 2022.

Course Coordinator	Local Coordinator
Dr. Dharmendra Tripathi Associate Professor, Mathematics National Institute of Technology, Uttarakhand Phone: +91-8385882005 Email: dtripathi@nituk.ac.in	**Dr. G.S. Brar** Associate Professor, Mechanical Engineering National Institute of Technology, Uttarakhand Phone: +91-9781991160 Email: brar.gurinder@nituk.ac.in