CORE COURSES

Introduction to Medical Informatics (BMIN7053)
Biomedical Informatics is an interdisciplinary field that combines knowledge of information sciences and medical sciences to optimize the use and application of biomedical data across the spectrum from molecules to individuals to populations. This course will present students with an introduction to the field of biomedical informatics through the use of core technologies and data science (computational and analytical methods) as it applies to clinical research and the use of health information technology to improve patient outcomes/healthcare delivery. Specific topics will include: overview of the field, data standards; security, confidentiality, regional health information exchange, standards, terminologies, database principles, data marts/data warehouses, interfaces and other topic as related to the healthcare and research setting. Learning objectives will be achieved using a variety of methods including: didactic lectures, group discussions, demonstrations, self-study, student projects, and selected readings from peer reviewed journal articles for each topic to develop critical analysis skills and ascertain real world applications.

Database Management Theory (EECE6010)
Database formal architectures emphasizing modeling and theory. Formal methods for database architectures; relational, hierarchical, object, object-relational and network; data dependencies, normalization, integrity constraints, concurrency, heterogeneous systems.

Introduction to Bioinformatics (BMIN7099)
Introduction to Bioinformatics is a multidisciplinary, entry level graduate course, which is an extension of current BME643 course and aims at achieving a deeper understanding of central algorithmic problems and current computational methods used in the context of data rich biomedical research. Subjects covered include: deep sequencing, biological sequence analysis, statistical models for gene expression profiling, prediction of protein and macromolecular complexes structure and function, systems biology. Analysis of algorithmic aspects will be accompanied by projects and case studies to provide a direct illustration of computational issues and to provide knowledge and practical command of standard bioinformatic tools and protocols that are being used to analyze complex biological data.

Data Science for Biomedical Research (BMIN7054)
Data Science for Biomedical Research will cover statistical and data mining techniques that are essential for processing, analyzing and mining Big Data, with the overarching goal of learning from data in order to gain useful predictions and insights.

Decision and Cost-Effectiveness Analysis (BE7068C)
Introduction to methods and applications of decision analysis and health economic analyses such as cost-effectiveness, and cost-benefit analyses in medical decision making. Key topics include the fundamentals of building decision models, Bayes' Theorem and the interpretation of diagnostic test results, patient preference-based utilities, design and assessment of economic analyses of health care, and advanced topics including Markov modeling, and Probabilistic Sensitivity Analysis using second order Monte Carlo modeling. The course format consists of a series of didactic lectures, workshops, and detailed clinical examples. Computer-based exercises are used during workshops, using decision modeling software [Decision Maker for Windows - WinDM®], and Excel™ spreadsheets. The culmination of the course is the development of a decision analytic application, usually a decision analysis. Many students have continued to work on their projects and have turned them into presentations at regional and national conferences and peer-reviewed publications.
Biomedical Informatics Practicum (BMIN8001)
The Biomedical Informatics Practicum is a project oriented course that combines the use of electronic medical records and other clinical informatics systems with research questions centered on Omics studies, personalized and preventive medicine, and quality of health care delivery. The projects will be designed to use state-of-the-art techniques and up to date data sets to identify current challenges develop solutions.

Ethics in Research (GNTD7003)
This course introduces students to ethical theories generally and the ethical and regulatory issues they are likely to encounter as researchers. Students will learn to identify issues, how to analyze ethical issues in research, and to develop coherent justifications for their ethical and responsible conduct of research.

Dissertation Research (BMIN8089)
Research tasks as advised by the dissertation adviser shall be completed.

GENERAL MEDICAL SCIENCES (Select 2)
Molecular and Cellular Biology (GNTD7001)
Primarily a lecture based course that represents the first course in the core curriculum series that is designed for all first year graduate students in the College of Medicine. Topics include DNA replication, recombination, and repair; Cell cycle regulation; Transcriptional regulation; Translational regulation; Protein trafficking; etc.

Introduction to Functional Genomics (GNTD8001C)
The course consists of lectures/seminars on the theory and use of functional genomics approaches in biomedical research. Each lecture is accompanied by a lab session in an electronic classroom that provides hands-on experience in practical application of functional genomics principles. A key part of the course is group research projects in which students analyze primary genomics data to answer research questions.

Introduction to Epidemiology (BE7076)
The course introduces methodology for studies of the cause of disease in human populations. Topics that are covered are chronic disease, infectious disease, and occupational and environmental epidemiology. Sources, collection, handling, and interpretation of health data are also discussed.

Principles of Clinical Trials (BE7066)

TECHNICAL ELECTIVES (Select 4)
Artificial Intelligence I (CS6033)
The course will cover in detail the topics of state space search, game tree search, constraint satisfaction, logic based knowledge representation and reasoning, first order predicate calculus, uncertainty handling using Bayesian probability theory, and some applications of these techniques. Applications may be selected from the area s of automated planning, natural language processing, or machine learning.
Digital Image Processing (EECE6042)
Digital image foundation and characterization, discrete transforms, image enhancement, encoding, compression and restoration. Prerequisite: senior or graduate standing.

Intelligent Data Analysis (CS6052)
This course will introduce students to the theoretical and practical aspects of the field of data mining. Algorithms for data mining will be covered and their relationships with statistics, mathematics, and algorithm design foundations will be explored in detail.

Advanced Algorithms I (CS7081)
Advanced treatment of fundamental topics in algorithms that every graduate student should know and have some sophistication in. Knowledge and ability to apply the fundamental design strategies: the greedy method, divide-and-conquer, dynamic programming, to solve important problems in data encryption, efficient polynomial, integer, matrix multiplication, computing the Discrete Fourier transform, using the celebrated FFT algorithm, and so forth. In addition this course will introduce students to lower bound theory and NP-completeness.

Cloud Computing (CS6065)

User Interface I (CS6067)
This course introduces the basic concepts of human computer interaction and the latest development of the technology for developing interactive systems. Major topics cover the role of computer technology, human users and human factors for designing windows-based applications, and design methodologies for building software applications

Pattern Recognition (CS8021)
The topics covered will include Statistical Pattern Recognition - its basics and applications, algorithms for clustering and their analysis. A flavour of different types of clustering algorithms will be given and a few algorithms will be studied in great depth. Relevance of all the above techniques for pattern discovery, classifier design, and dimensionality reduction will be investigated. A number of examples from real-life datasets will be examined in depth during the class presentations and by students during their homework assignments.

Data Warehouse Design (EECE8075)
Data warehouse design with conceptual data models and physical storage techniques; data mining techniques including clustering, pattern recognition, and data visualization.

Biostatistics in Research (BME7061)
In this course a number of statistical methods will be presented to analyze various types of data stemming from research. A rudimentary knowledge of probability and inferential statistics will be assumed. How to evaluate a diagnostic test will be dealt in depth. Analysis of contingency tables and loglinear models will be presented to answer a number of relevant research questions. A detailed presentation of logistic regression and rudiments of Survival Analysis will be presented. Presentation of current research from journals.
Advanced Statistical Methods in Biomedical Research (BME8064)
Summary statistics of multivariate data; principal components; factor analysis; multivariate analysis of variance; multivariate multiple regression; multidimensional scaling; heat maps; multivariate graphics; pattern recognition; cluster analysis; random forests.

Introduction to Biostatistics (BE7022)
Students will learn basic statistics such as mean, median, mode, standard deviation, variance, etc. Topics include probability, parametric statistics such as t tests and one way analysis of variance, and nonparametric statistics including both Wilcoxon tests and Kaplan-Meier estimation of survival. Bayes theorem, discrete (e.g. Binomial) and continuous probability distributions (e.g. normal distributions and one variable regression and product moment correlation and rank correlation are covered.

Applied Bayesian Analysis (STAT6043)
Foundation of Bayesian Statistics, basic theory and several applications including Monte Carlo and Markov Chain Monte Carlo Methods for computing Bayesian inference will be covered. Specific topics include: Foundation of Bayesian Approach, Prior and Posterior distributions; Choice of Priors: subjective and non-subjective or default approaches; Inference using posterior distribution for standard models; and Hierarchical models, and their applications. WinBUGS will be introduced.

Advanced Health Care Data Analytics, Business Intelligence and Reporting (BANA7015)
This course teaches the use of healthcare data to make decisions and transform healthcare delivery and the health of individuals and populations. The course concentrates on big and small data, and structured and unstructured data. Tools, applications and approaches for health data analytics are taught. This course covers topics such as statistical approaches; data, web and text mining; data visualization, simulation, modeling and forecasting. Key regulatory health and healthcare reporting requirements are taught.

Community-Based Participatory Research (BE7074)
This class is designed to familiarize learners with the theoretical framework, methodologies, and applications of community-based participatory research and how it differs from traditional research approaches and community-placed research.

Quality Improvement and Patient Safety (BE7071)
This course will cover the fundamentals of quality improvement and patient safety. It will use a framework of human factors to facilitate understanding complex system failures and successful strategies to reduce hazard in industrial and medical environments. The concepts are taught using a case-based format to explore common human and organizational sources of failure, such as missing or inert knowledge, communication/collaboration, clumsy technology, human computer interaction (alerts and reminders), and role of a safety culture. The second half of the course is devoted to learning approaches for implementing evidenced-based practices based on Rogers’ theory, where adopting innovation in an organization is divided into two major activities: initiation and implementation.

Healthcare Operations Management (OM7022)
In this course, we will examine several key areas in which healthcare needs to improve, such as: designing a better patient (customer) experience; misalignment between individual incentives and organizational goals; innovation and the process of developing and commercializing new service products; and overly long patient (customer) waiting and poor access. In addition, we will review several techniques that could be used to achieve these improvements.
Quantitative and Qualitative Data Collection Methods for Health Services Research (BE7070)
In this course, students will learn concepts, methods, and practical procedures for developing and implementing quantitative and qualitative health survey instruments to answer their own research questions. Through hands-on learning, students will gain experience in instrument design and construction, sampling considerations, data collection methods, coding, processing (including automated methods), presentation, and data analysis. Each student will identify a health-related research question and design qualitative and quantitative instruments and methods for answering it.

Analysis of Internet Health Data (BE7080)
Examples of internet data: Framingham Health Data; National Inpatient Sample; Nurses Health Data; Emergency Admissions Data; Pediatric Admissions Data. Description of data sets. Analysis of Inpatient Sample Data. R package for data analysis. New research projects.