Ⅰ.3.4.B First Year Outline Syllabus

Integrated M.Sc. in Intelligent Health Systems

Pre-Semester Courses

Bridge to Global Intelligent Health Technology Education

GFT-PS1101: Mathematical and Health Data Readiness

L:T:P: 0:2:0
Credits: 2

Unit I: Number Sense, Algebra and Health Quantities

Numbers, variables, expressions, ratios, percentages, rates, proportions, units, measurement, dosage-like reasoning, health indicators and basic quantitative interpretation.

Unit II: Functions, Graphs and Health Data Patterns

Functions, graphs, trends, growth and decay, rates of change, time-series intuition, disease trends, patient vitals and public health indicators.

Unit III: Vectors, Matrices and Health Data Representation

Coordinates, vectors, matrices, tabular representation, patient-feature representation, matrix view of health records, similarity and distance intuition.

Unit IV: Probability, Uncertainty and Introductory Health Statistics

Events, probability, uncertainty, risk, averages, variation, distributions, correlation, causation and introductory interpretation of health data.

Textbooks / References

1. Gilbert Strang, *Introduction to Linear Algebra*, Wellesley-Cambridge Press.
2. David C. Lay, Steven R. Lay and Judi J. McDonald, *Linear Algebra and Its Applications*, Pearson.
3. Joseph K. Blitzstein and Jessica Hwang, *Introduction to Probability*, CRC Press.
4. Sheldon M. Ross, *A First Course in Probability*, Pearson.
5. Marc Peter Deisenroth, A. Aldo Faisal and Cheng Soon Ong, *Mathematics for Machine Learning*, Cambridge University Press.
6. Wayne W. Daniel and Chad L. Cross, *Biostatistics: A Foundation for Analysis in the Health Sciences*, Wiley.

GFT-PS1102: Computational Thinking and Problem Solving

L:T:P: 0:1:1
Credits: 2

Unit I: Foundations of Computational Thinking

Problem understanding, decomposition, abstraction, pattern recognition, logical reasoning, algorithmic thinking and stepwise solution design.

Unit II: Algorithms, Flowcharts and Pseudocode

Algorithm writing, flowcharts, pseudocode, sequence, selection, iteration, dry runs, trace tables and structured problem representation.

Unit III: Problem-Solving Strategies for Health Contexts

Search, sorting intuition, rule-based decisions, triage-like reasoning, constraints, edge cases, validation and simple automation ideas.

Unit IV: Practice with Health-Oriented Problems

Basic health workflow problems, appointment logic, patient queue logic, simple rule systems, tabular reasoning and transition from problem to program.

Textbooks / References

1. David D. Riley and Kenny A. Hunt, *Computational Thinking for the Modern Problem Solver*, CRC Press.
2. John V. Guttag, *Introduction to Computation and Programming Using Python*, MIT Press.
3. Allen B. Downey, *Think Python*, O'Reilly Media.
4. Bradley N. Miller and David L. Ranum, *Problem Solving with Algorithms and Data Structures Using Python*, Franklin, Beedle & Associates.
5. Jeannette M. Wing, *Computational Thinking*, Communications of the ACM.

GFT-PS1103: Digital Learning, AI Tools and Health Academic Readiness

L:T:P: 0:1:1
Credits: 2

Unit I: Digital Academic Readiness

Digital identity, learning platforms, file organization, digital communication, academic discipline, online safety and responsible digital conduct.

Unit II: Health Information Literacy and Knowledge Discovery

Searching health information, evaluating sources, evidence hierarchy, citation awareness, plagiarism, academic integrity and structured note-making.

Unit III: AI Tools for Health Learning and Research Readiness

AI assistants, prompt formulation, AI-assisted learning, verification, bias, hallucination, responsible AI use and health-domain caution.

Unit IV: Academic Productivity and Health-Tech Portfolio Readiness

Documents, spreadsheets, presentations, collaborative tools, reflective logs, portfolio evidence, health-data notes and digital learning records.

Textbooks / References

1. Mike Caulfield and Sam Wineburg, *Verified: How to Think Straight, Get Duped Less, and Make Better Decisions about What to Believe Online*, University of Chicago Press.
2. Barbara Oakley and Terrence Sejnowski, *Learning How to Learn*, TarcherPerigee.
3. Paul Gilster, *Digital Literacy*, Wiley.
4. Ethan Mollick, *Co-Intelligence: Living and Working with AI*, Portfolio.
5. Trisha Greenhalgh, *How to Read a Paper: The Basics of Evidence-Based Medicine and Healthcare*, Wiley-Blackwell.

GFT-PS1104: Programming Readiness and Self-Practice Studio

L:T:P: 0:0:2
Credits: 2

Unit I: Programming Orientation

Problem-to-program thinking, programming environment, input, output, variables, expressions and basic execution flow.

Unit II: Conditions, Loops and Logic

Conditional statements, relational operators, logical operators, loops, nested decisions and iterative problem solving.

Unit III: Functions, Debugging and Modular Thinking

Functions, parameters, return values, reuse, tracing, debugging, errors and beginner-level program correction.

Unit IV: Beginner Programming Practice for Health Contexts

Number problems, string basics, list basics, tabular data basics, health-record-like examples and auto-evaluated micro exercises.

Textbooks / References

1. Allen B. Downey, *Think Python*, O'Reilly Media.
2. John V. Guttag, *Introduction to Computation and Programming Using Python*, MIT Press.
3. Charles Severance, *Python for Everybody*, CreateSpace.
4. Eric Matthes, *Python Crash Course*, No Starch Press.
5. Mark Lutz, *Learning Python*, O'Reilly Media.

Semester I Courses

Foundations of Science, Health Systems, Computing and Health Data

GFT-IHS1101: Scientific Thinking, Human Health Systems and Global Health-Tech Orientation

L:T:P: 2:1:1
Credits: 4

Unit I: Scientific Thinking and Evidence-Based Reasoning

Observation, questioning, hypothesis, evidence, experiment, falsifiability, causality, uncertainty and scientific attitude.

Unit II: Human Health Systems Orientation

Human body as a system, health and disease, prevention, diagnosis, treatment, care pathways, patient journey and health determinants.

Unit III: Healthcare Ecosystem and Health Systems Thinking

Hospitals, clinics, laboratories, pharmacies, public health systems, insurance, health operations, patient flow and healthcare stakeholders.

Unit IV: Global Health-Tech and Intelligent Health Systems

Digital health, AI in healthcare, medical devices, health informatics, clinical decision support, telehealth, patient safety and ethical technology.

Textbooks / References

1. Carl Sagan, *The Demon-Haunted World: Science as a Candle in the Dark*, Ballantine Books.
2. Peter Godfrey-Smith, *Theory and Reality: An Introduction to the Philosophy of Science*, University of Chicago Press.
3. Donella H. Meadows, *Thinking in Systems*, Chelsea Green Publishing.
4. William B. Rouse and Nicoleta Serban, *Understanding and Managing the Complexity of Healthcare*, MIT Press.
5. Rifat Latifi, *The Modern Hospital: Patients Centered, Disease Based, Research Oriented, Technology Driven*, Springer.
6. Robert Wachter, *The Digital Doctor: Hope, Hype, and Harm at the Dawn of Medicine's Computer Age*, McGraw-Hill.

GFT-IHS1102: Python Programming for Health Problem Solving

L:T:P: 1:1:2
Credits: 4

Unit I: Python Foundations

Python environment, variables, data types, expressions, input-output, operators and basic program structure.

Unit II: Control Flow and Functions

Conditional statements, loops, nested loops, functions, parameters, return values, scope and program tracing.

Unit III: Python Data Structures for Health Data

Strings, lists, tuples, dictionaries, sets, iteration, patient-record-like data representation and simple data manipulation.

Unit IV: Files, Modules and Health Problem Solving

File handling, CSV files, exceptions, basic libraries, debugging, testing and health-oriented programming exercises.

Textbooks / References

1. John V. Guttag, *Introduction to Computation and Programming Using Python*, MIT Press.
2. Allen B. Downey, *Think Python*, O'Reilly Media.
3. Charles Severance, *Python for Everybody*, CreateSpace.
4. Eric Matthes, *Python Crash Course*, No Starch Press.
5. Wes McKinney, *Python for Data Analysis*, O'Reilly Media.

GFT-IHS1103: Foundations of Health Data Literacy, Digital Health and Patient Data Systems

L:T:P: 2:1:1
Credits: 4

Unit I: Health Data Literacy Foundations

Data, information, knowledge, health data types, variables, measurement, patient data, clinical data, public health data and data quality.

Unit II: Patient Data and Healthcare Information Systems

Patient registration, encounters, observations, laboratory data, medication data, diagnosis data, EHR, HIS, LIS, RIS and pharmacy systems.

Unit III: Digital Health Systems and Platforms

Telehealth, mobile health, remote monitoring, patient portals, digital therapeutics, health apps, digital workflows and connected care.

Unit IV: Health Data Ethics, Privacy and Responsible Use

Confidentiality, consent, privacy, patient safety, data ownership, bias, responsible data use and introductory regulatory awareness.

Textbooks / References

1. Edward H. Shortliffe and James J. Cimino, *Biomedical Informatics: Computer Applications in Health Care and Biomedicine*, Springer.
2. Robert E. Hoyt and Ann K. Yoshihashi, *Health Informatics: Practical Guide*, Lulu Press.
3. Enrico Coiera, *Guide to Health Informatics*, CRC Press.
4. Brian W. Kernighan, *Understanding the Digital World*, Princeton University Press.
5. David Spiegelhalter, *The Art of Statistics: Learning from Data*, Pelican.
6. Robert Wachter, *The Digital Doctor*, McGraw-Hill.

Semester II Courses

Mathematics, Biostatistics, Programming and Health Data Foundations

GFT-IHS1201: Mathematics, Linear Algebra and Matrix Methods for Health AI

L:T:P: 2:1:1
Credits: 4

Unit I: Linear Equations and Matrices

Linear equations, systems of equations, matrix notation, row operations, Gaussian elimination, matrix algebra and inverse matrices.

Unit II: Vectors, Vector Spaces and Health Feature Representation

Vectors, span, linear independence, basis, dimension, rank, patient features, biomedical features and health-data representation.

Unit III: Orthogonality, Projections and Least Squares

Dot product, norm, distance, similarity, orthogonality, projections, least squares and health-data fitting intuition.

Unit IV: Eigenvalues, Dimensionality Reduction and Health AI Applications

Eigenvalues, eigenvectors, diagonalization intuition, PCA, feature spaces, imaging data intuition and matrix methods in health AI.

Textbooks / References

1. Gilbert Strang, *Introduction to Linear Algebra*, Wellesley-Cambridge Press.
2. David C. Lay, Steven R. Lay and Judi J. McDonald, *Linear Algebra and Its Applications*, Pearson.
3. Howard Anton and Chris Rorres, *Elementary Linear Algebra*, Wiley.
4. Marc Peter Deisenroth, A. Aldo Faisal and Cheng Soon Ong, *Mathematics for Machine Learning*, Cambridge University Press.
5. Stephen H. Friedberg, Arnold J. Insel and Lawrence E. Spence, *Linear Algebra*, Pearson.

GFT-IHS1202: Probability, Biostatistics, Epidemiology and Clinical Model Evaluation Foundations

L:T:P: 2:1:1
Credits: 4

Unit I: Descriptive Biostatistics and Health Data Distributions

Health data types, sampling, frequency distributions, mean, median, mode, variance, standard deviation, prevalence and incidence.

Unit II: Probability, Risk and Diagnostic Reasoning

Sample spaces, events, probability rules, conditional probability, independence, Bayes' theorem, risk, sensitivity and specificity intuition.

Unit III: Random Variables, Distributions and Epidemiological Measures

Random variables, expectation, variance, Bernoulli, binomial, Poisson, normal distribution, relative risk, odds ratio and rates.

Unit IV: Statistical Inference and Clinical Model Evaluation Basics

Sampling distributions, confidence intervals, hypothesis testing, p-values, correlation, regression intuition, AUROC intuition and model evaluation.

Textbooks / References

1. Wayne W. Daniel and Chad L. Cross, *Biostatistics: A Foundation for Analysis in the Health Sciences*, Wiley.
2. Bernard Rosner, *Fundamentals of Biostatistics*, Cengage Learning.
3. Joseph K. Blitzstein and Jessica Hwang, *Introduction to Probability*, CRC Press.
4. Kenneth J. Rothman, Sander Greenland and Timothy L. Lash, *Modern Epidemiology*, Wolters Kluwer.
5. Leon Gordis, *Epidemiology*, Elsevier.
6. David W. Hosmer, Stanley Lemeshow and Rodney X. Sturdivant, *Applied Logistic Regression*, Wiley.

GFT-IHS1203: Programming Structures and Algorithmic Thinking for Health Applications

L:T:P: 1:1:2
Credits: 4

Unit I: Structured Programming and Decomposition

Program design, decomposition, functions, modularity, recursion basics, tracing, debugging and health workflow logic.

Unit II: Data Structures for Health Applications

Lists, strings, dictionaries, sets, stacks, queues, tables, simple records and health data organization.

Unit III: Algorithmic Thinking and Efficiency

Searching, sorting, recursion, complexity intuition, brute force, greedy thinking, divide-and-conquer intuition and validation.

Unit IV: Applied Health Programming Practice

Patient record processing, appointment logic, simple triage rules, health-data validation, edge cases, testing and auto-evaluated exercises.

Textbooks / References

1. John V. Guttag, *Introduction to Computation and Programming Using Python*, MIT Press.
2. Allen B. Downey, *Think Python*, O'Reilly Media.
3. Bradley N. Miller and David L. Ranum, *Problem Solving with Algorithms and Data Structures Using Python*, Franklin, Beedle & Associates.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, *Introduction to Algorithms*, MIT Press.
5. Steven S. Skiena, *The Algorithm Design Manual*, Springer.

GFT-IHS1204: Health Data Handling, Visualization and Exploratory Analysis

L:T:P: 1:1:2
Credits: 4

Unit I: Health Data Sources and Data Handling

Health datasets, CSV, JSON, spreadsheets, EHR-like tables, laboratory data, public health data, missing values and data cleaning.

Unit II: Exploratory Health Data Analysis

Summary statistics, grouping, aggregation, filtering, sorting, outliers, distributions, patient cohorts and health-data relationships.

Unit III: Health Data Visualization

Charts, plots, histograms, scatter plots, box plots, heatmaps, dashboards, public health maps, visual encoding and visualization ethics.

Unit IV: Applied Health Data Analysis and Reporting

End-to-end exploratory analysis, health-data interpretation, data storytelling, reproducible notebooks, report writing and evidence presentation.

Textbooks / References

1. Wes McKinney, *Python for Data Analysis*, O'Reilly Media.
2. Jake VanderPlas, *Python Data Science Handbook*, O'Reilly Media.
3. Hadley Wickham and Garrett Grolemund, *R for Data Science*, O'Reilly Media.
4. John W. Tukey, *Exploratory Data Analysis*, Addison-Wesley.
5. Alberto Cairo, *The Truthful Art: Data, Charts, and Maps for Communication*, New Riders.
6. Kieran Healy, *Data Visualization: A Practical Introduction*, Princeton University Press.

GFT-IHS1205: Mini Project I — Health Data Story, Problem Discovery and Evidence Report

L:T:P: 0:1:3
Credits: 4

Unit I: Health Problem Discovery and Context Understanding

Problem identification, healthcare context, stakeholder mapping, patient journey, hospital/public health observation and problem framing.

Unit II: Health Data Discovery and Collection

Health data sources, open datasets, observation sheets, surveys, secondary data, data dictionaries, ethics, privacy and consent awareness.

Unit III: Health Data Preparation and Exploratory Analysis

Data cleaning, tabulation, descriptive analysis, visualization, pattern identification, early insights and evidence interpretation.

Unit IV: Health Evidence Report and Portfolio Presentation

Problem statement, methodology, findings, limitations, health relevance, presentation, reflective learning and portfolio documentation.

Textbooks / References

1. Cathy O'Neil and Rachel Schutt, *Doing Data Science*, O'Reilly Media.
2. Foster Provost and Tom Fawcett, *Data Science for Business*, O'Reilly Media.
3. Joel Grus, *Data Science from Scratch*, O'Reilly Media.
4. Trisha Greenhalgh, *How to Read a Paper: The Basics of Evidence-Based Medicine and Healthcare*, Wiley-Blackwell.
5. Edward H. Shortliffe and James J. Cimino, *Biomedical Informatics: Computer Applications in Health Care and Biomedicine*, Springer.
6. Kieran Healy, *Data Visualization: A Practical Introduction*, Princeton University Press.