Ⅰ.3.4. D (*Detour)* Syllabus

Post-B.Sc. M.Sc. in Intelligent Health Systems

With Track A / Track B Personalized First-Year Foundation and Year-II Merger

Programme Structure

Track A

For candidates from Biology, Life Sciences, Biotechnology, Microbiology, Biochemistry, Genetics, Zoology, Botany, Allied Health Sciences, Public Health, Nutrition and related backgrounds without adequate mathematics / computer science foundation.

Track B

For candidates from Computer Science, Mathematics, Statistics, Data Science, Physics, Electronics, IT and related quantitatively strong disciplines without adequate biology / health science foundation.

Credit Structure

Stage	**Qualifying Credits**	**Compulsory Add-on Major Track Credits**	**Total Credits**
Semester I	20	4	24
Semester II	20	4	24
Summer Term	0	8	8
Semester III	20	4	24
Semester IV	16	4	20
Total	**76**	**24**	**100**

PART A
TRACK A: Biology / Life Sciences to Intelligent Health Systems

Semester I — Track A

Computational and Mathematical Elevation for Health AI

GFT-MIHA4101: Python Programming and Computational Thinking for Health Sciences

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

Unit I: Python and Computational Thinking Foundations

Problem decomposition, abstraction, algorithms, Python environment, variables, expressions, input-output and basic program structure.

Unit II: Control Flow and Functions

Conditional statements, loops, nested decisions, functions, parameters, return values, tracing and debugging.

Unit III: Data Structures for Health Data

Strings, lists, tuples, dictionaries, sets, tabular data representation and patient-record-like data structures.

Unit IV: Health-Oriented Programming Practice

CSV files, basic data processing, simple health calculators, patient table processing, validation and notebook-based practice.

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-MIHA4102: Mathematics, Linear Algebra and Biostatistics Readiness for Health AI

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

Unit I: Mathematical Readiness for Health AI

Numbers, ratios, percentages, functions, graphs, rates, growth, decay, logarithmic intuition and health-data quantities.

Unit II: Linear Algebra and Matrix Representation

Vectors, matrices, systems of equations, matrix operations, distance, similarity, patient-feature representation and biomedical data matrices.

Unit III: Probability and Uncertainty in Health

Events, probability rules, conditional probability, Bayes' theorem, risk, uncertainty, diagnostic reasoning and prediction.

Unit IV: Biostatistics Readiness

Mean, median, mode, variance, standard deviation, distributions, sampling, confidence intervals and introductory hypothesis testing.

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. Wayne W. Daniel and Chad L. Cross, *Biostatistics: A Foundation for Analysis in the Health Sciences*, Wiley.
4. Joseph K. Blitzstein and Jessica Hwang, *Introduction to Probability*, CRC Press.
5. Bernard Rosner, *Fundamentals of Biostatistics*, Cengage Learning.

GFT-MIHA4103: Data Structures, Algorithms and Health Data Processing

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

Unit I: Algorithmic Thinking and Structured Problem Solving

Problem formulation, decomposition, algorithm design, tracing, recursion basics and computational efficiency.

Unit II: Core Data Structures

Arrays/lists, strings, stacks, queues, dictionaries, sets, trees and graph intuition for health data problems.

Unit III: Searching, Sorting and Processing Algorithms

Searching, sorting, filtering, grouping, aggregation, rule-based processing and complexity intuition.

Unit IV: Health Data Processing Practice

Patient records, appointment lists, lab data, cohort filtering, health indicators and auto-evaluated programming exercises.

Textbooks / References

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

GFT-MIHA4104: Databases, Health Data Modelling and Digital Records

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

Unit I: Database Foundations

Data, databases, DBMS, relational model, tables, keys, constraints, schemas and entity-relationship modelling.

Unit II: SQL and Structured Health Data

SQL queries, joins, filtering, aggregation, subqueries, views and structured clinical data retrieval.

Unit III: Health Data Models and Digital Records

Patient registration, encounters, observations, diagnosis, medication, lab reports, EHR-style tables and health data dictionaries.

Unit IV: Health Data Quality and Governance

Missing values, duplicate records, validation, privacy, consent, responsible data handling and introductory data governance.

Textbooks / References

1. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, *Database System Concepts*, McGraw-Hill.
2. Ramez Elmasri and Shamkant B. Navathe, *Fundamentals of Database Systems*, Pearson.
3. Edward H. Shortliffe and James J. Cimino, *Biomedical Informatics: Computer Applications in Health Care and Biomedicine*, Springer.
4. Robert E. Hoyt and Ann K. Yoshihashi, *Health Informatics: Practical Guide*, Lulu Press.
5. Enrico Coiera, *Guide to Health Informatics*, CRC Press.

GFT-MIHA4105: Foundations of AI, Machine Learning and Intelligent Health Systems

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

Unit I: Foundations of Artificial Intelligence

Meaning of intelligence, AI history, agents, environments, problem formulation, search, reasoning and intelligent action.

Unit II: Machine Learning Foundations

Data, features, labels, supervised learning, unsupervised learning, model training, testing and evaluation.

Unit III: AI in Healthcare

Clinical prediction, diagnosis support, hospital analytics, public health intelligence, medical imaging AI and wearable intelligence.

Unit IV: Responsible Intelligent Health Systems

Patient safety, bias, explainability, privacy, human oversight, ethical AI and health AI deployment considerations.

Textbooks / References

1. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, Pearson.
2. Melanie Mitchell, *Artificial Intelligence: A Guide for Thinking Humans*, Farrar, Straus and Giroux.
3. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer.
4. Eric Topol, *Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again*, Basic Books.
5. Edward H. Shortliffe and James J. Cimino, *Biomedical Informatics*, Springer.

GFT-MIHAO4101: Major Track Studio A-I — Programming, Mathematics and Health Data Practice Intensive

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

Unit I: Python Practice Intensive

Beginner-to-intermediate programming exercises, functions, loops, file handling and debugging.

Unit II: Mathematics and Biostatistics Practice

Vectors, matrices, probability, descriptive statistics, risk and health indicator calculations.

Unit III: Health Data Representation Practice

Patient tables, lab values, diagnosis codes, health records, cohort data and spreadsheet-to-database practice.

Unit IV: Practice Portfolio

Programming notebooks, health-data worksheets, mini dashboards, reflection notes and portfolio review.

Textbooks / References

1. Allen B. Downey, *Think Python*, O'Reilly Media.
2. Wes McKinney, *Python for Data Analysis*, O'Reilly Media.
3. Wayne W. Daniel and Chad L. Cross, *Biostatistics*, Wiley.
4. Jake VanderPlas, *Python Data Science Handbook*, O'Reilly Media.
5. Robert E. Hoyt and Ann K. Yoshihashi, *Health Informatics: Practical Guide*, Lulu Press.

Semester II — Track A

AI, Health Data and Digital Health Application Strengthening

GFT-MIHA4201: Machine Learning for Health Data and Clinical Prediction

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

Unit I: Machine Learning Workflow for Health Data

Datasets, features, labels, training, validation, testing, preprocessing and health-data problem formulation.

Unit II: Supervised Learning for Health Prediction

Regression, classification, logistic regression, decision trees, random forests, support vector machines and clinical risk prediction.

Unit III: Unsupervised Learning and Patient Stratification

Clustering, dimensionality reduction, anomaly detection, patient segmentation and cohort discovery.

Unit IV: Clinical Model Evaluation

Accuracy, precision, recall, sensitivity, specificity, AUROC, calibration, bias, explainability and model reporting.

Textbooks / References

1. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly Media.
2. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer.
3. Kevin P. Murphy, *Machine Learning: A Probabilistic Perspective*, MIT Press.
4. David W. Hosmer, Stanley Lemeshow and Rodney X. Sturdivant, *Applied Logistic Regression*, Wiley.
5. Gareth James et al., *An Introduction to Statistical Learning*, Springer.

GFT-MIHA4202: Deep Learning and Biomedical Data Representation

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

Unit I: Neural Network Foundations

Perceptrons, multilayer networks, activation functions, loss functions, optimization and backpropagation.

Unit II: Deep Learning Architectures

CNNs, RNNs, sequence models, embeddings, attention intuition and transformer orientation.

Unit III: Biomedical Data Representation

Images, signals, clinical notes, tabular health data, omics data, embeddings and representation learning.

Unit IV: Responsible Deep Learning in Healthcare

Training practice, overfitting, interpretability, model validation, bias, patient safety and clinical limitations.

Textbooks / References

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, *Deep Learning*, MIT Press.
2. François Chollet, *Deep Learning with Python*, Manning.
3. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly Media.
4. Charu C. Aggarwal, *Neural Networks and Deep Learning*, Springer.
5. Eric Topol, *Deep Medicine*, Basic Books.

GFT-MIHA4203: Health Data Engineering, FHIR, APIs and Interoperability Foundations

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

Unit I: Health Data Engineering Foundations

Data sources, ingestion, storage, transformation, data quality, health data pipelines and metadata.

Unit II: Health Interoperability Basics

EHR, HIS, LIS, RIS, FHIR resources, HL7 orientation, DICOM orientation and health information exchange.

Unit III: APIs and Health Data Services

REST APIs, JSON, authentication orientation, health record exchange, API documentation and integration thinking.

Unit IV: Applied Health Data Pipeline Practice

Data cleaning, transformation, FHIR-style representation, dashboard-ready datasets and pipeline documentation.

Textbooks / References

1. Joe Reis and Matt Housley, *Fundamentals of Data Engineering*, O'Reilly Media.
2. Martin Kleppmann, *Designing Data-Intensive Applications*, O'Reilly Media.
3. Edward H. Shortliffe and James J. Cimino, *Biomedical Informatics*, Springer.
4. Robert E. Hoyt and Ann K. Yoshihashi, *Health Informatics: Practical Guide*, Lulu Press.
5. Tim Benson and Grahame Grieve, *Principles of Health Interoperability*, Springer.

GFT-MIHA4204: Digital Health Application Engineering and Health Product Prototyping

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

Unit I: Digital Health Product Foundations

Digital health, telehealth, mobile health, patient portals, remote monitoring, digital therapeutics and health product ecosystem.

Unit II: Application Engineering Foundations

Application architecture, database-backed applications, APIs, dashboards, user workflows and authentication orientation.

Unit III: Health Product Design and User Experience

Patient journey, clinician workflow, usability, accessibility, human-centred design and health communication.

Unit IV: Prototype Development and Demonstration

Low-fidelity to working prototype, testing, demo, documentation, product note and deployment orientation.

Textbooks / References

1. Robert Wachter, *The Digital Doctor*, McGraw-Hill.
2. Eric Topol, *The Patient Will See You Now*, Basic Books.
3. Marty Cagan, *Inspired: How to Create Tech Products Customers Love*, Wiley.
4. Alan Cooper et al., *About Face: The Essentials of Interaction Design*, Wiley.
5. Brian W. Kernighan, *Understanding the Digital World*, Princeton University Press.

GFT-MIHA4205: Applied Health AI Lab I — ML and Digital Health Prototype

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

Unit I: Problem Framing and Dataset Preparation

Health problem selection, dataset discovery, cleaning, feature engineering and baseline analysis.

Unit II: Model Building and Evaluation

Training, validation, testing, error analysis, clinical metrics, interpretation and model documentation.

Unit III: Prototype Integration

Dashboard/API integration, user workflow, model output presentation, explainability note and prototype testing.

Unit IV: Final Demonstration and Portfolio

Technical report, model card, ethics note, demo video, presentation and portfolio evidence.

Textbooks / References

1. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly Media.
2. Chip Huyen, *Designing Machine Learning Systems*, O'Reilly Media.
3. Cathy O'Neil and Rachel Schutt, *Doing Data Science*, O'Reilly Media.
4. Foster Provost and Tom Fawcett, *Data Science for Business*, O'Reilly Media.
5. Emmanuel Ameisen, *Building Machine Learning Powered Applications*, O'Reilly Media.

GFT-MIHAO4201: Major Track Studio A-II — Applied Biostatistics, Model Evaluation and Health AI Reasoning

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

Unit I: Biostatistics Practice for Health AI

Prevalence, incidence, risk, odds ratio, relative risk, confidence intervals and hypothesis testing practice.

Unit II: Clinical Model Evaluation Practice

Sensitivity, specificity, PPV, NPV, AUROC, AUPRC, calibration and subgroup evaluation.

Unit III: Model Interpretation and Error Analysis

Feature importance, explainability, error groups, bias checks, false positives, false negatives and safety reflection.

Unit IV: Evaluation Portfolio

Clinical model evaluation report, notebooks, performance dashboard and health AI reasoning documentation.

Textbooks / References

1. Wayne W. Daniel and Chad L. Cross, *Biostatistics*, Wiley.
2. Bernard Rosner, *Fundamentals of Biostatistics*, Cengage Learning.
3. David W. Hosmer et al., *Applied Logistic Regression*, Wiley.
4. Gareth James et al., *An Introduction to Statistical Learning*, Springer.
5. Trevor Hastie, Robert Tibshirani and Jerome Friedman, *The Elements of Statistical Learning*, Springer.

PART B

TRACK B: CS / Mathematics / Statistics / Data / Physical Sciences to Intelligent Health Systems

Semester I — Track B

Health, Biology and Clinical Systems Elevation

GFT-MIHB4101: Human Biology, Physiology and Disease Systems for Health AI

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

Unit I: Human Body Systems Orientation

Cells, tissues, organs, homeostasis, major body systems and systems view of human health.

Unit II: Physiology and Health Functioning

Cardiovascular, respiratory, nervous, endocrine, digestive, renal and musculoskeletal system functions.

Unit III: Disease Systems and Clinical Reasoning

Pathophysiology basics, infection, inflammation, chronic disease, diagnosis, treatment and care pathways.

Unit IV: Health AI Relevance

Clinical variables, symptoms, signs, biomarkers, disease prediction, monitoring and health data interpretation.

Textbooks / References

1. Arthur C. Guyton and John E. Hall, *Textbook of Medical Physiology*, Elsevier.
2. Elaine N. Marieb and Katja Hoehn, *Human Anatomy & Physiology*, Pearson.
3. Gerard J. Tortora and Bryan Derrickson, *Principles of Anatomy and Physiology*, Wiley.
4. Robbins and Cotran, *Pathologic Basis of Disease*, Elsevier.
5. Eric Topol, *Deep Medicine*, Basic Books.

GFT-MIHB4102: Medical Terminology, Clinical Workflows and Patient Journey

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

Unit I: Medical Terminology Foundations

Roots, prefixes, suffixes, abbreviations, clinical vocabulary, diagnostic terms and procedure terminology.

Unit II: Patient Journey and Care Pathways

Registration, triage, consultation, investigation, diagnosis, treatment, discharge, follow-up and referral pathways.

Unit III: Hospital and Clinical Workflows

Outpatient, inpatient, emergency, laboratory, radiology, pharmacy, surgery, ICU and nursing workflows.

Unit IV: Clinical Documentation and Workflow Intelligence

Case sheets, discharge summaries, prescriptions, lab reports, imaging reports, workflow bottlenecks and digital transformation opportunities.

Textbooks / References

1. Davi-Ellen Chabner, *Medical Terminology: A Short Course*, Elsevier.
2. Barbara Janson Cohen and Ann DePetris, *Medical Terminology: An Illustrated Guide*, Wolters Kluwer.
3. Rifat Latifi, *The Modern Hospital*, Springer.
4. Robert Wachter, *The Digital Doctor*, McGraw-Hill.
5. Edward H. Shortliffe and James J. Cimino, *Biomedical Informatics*, Springer.

GFT-MIHB4103: Health Data Literacy, EHR, HIS and Patient Data Systems

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

Unit I: Health Data Literacy

Health data types, clinical variables, patient identifiers, measurements, laboratory values, medications and diagnosis data.

Unit II: Electronic Health Records and Hospital Systems

EHR, EMR, HIS, LIS, RIS, PACS, pharmacy systems, billing systems and hospital data flow.

Unit III: Health Data Standards and Models

FHIR orientation, HL7 orientation, DICOM orientation, ICD, SNOMED CT, LOINC and health data dictionaries.

Unit IV: Patient Data Systems Practice

Patient registration model, encounter model, observation model, lab data table, medication table and simple EHR workflow mapping.

Textbooks / References

1. Edward H. Shortliffe and James J. Cimino, *Biomedical Informatics*, 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. Tim Benson and Grahame Grieve, *Principles of Health Interoperability*, Springer.
5. Robert Wachter, *The Digital Doctor*, McGraw-Hill.

GFT-MIHB4104: Biostatistics, Epidemiology and Clinical Evidence Foundations

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

Unit I: Descriptive Biostatistics

Health data types, sampling, mean, median, mode, variance, standard deviation, distributions and visualization.

Unit II: Epidemiology Foundations

Prevalence, incidence, risk factors, screening, surveillance, population health and epidemiological study designs.

Unit III: Clinical Evidence and Diagnostic Reasoning

Sensitivity, specificity, predictive values, likelihood ratios, clinical trials, evidence hierarchy and bias.

Unit IV: Statistical Inference for Health Decisions

Confidence intervals, hypothesis testing, p-values, correlation, regression intuition and clinical interpretation.

Textbooks / References

1. Wayne W. Daniel and Chad L. Cross, *Biostatistics*, Wiley.
2. Bernard Rosner, *Fundamentals of Biostatistics*, Cengage Learning.
3. Leon Gordis, *Epidemiology*, Elsevier.
4. Kenneth J. Rothman, Sander Greenland and Timothy L. Lash, *Modern Epidemiology*, Wolters Kluwer.
5. Trisha Greenhalgh, *How to Read a Paper*, Wiley-Blackwell.

GFT-MIHB4105: Foundations of Digital Health, Public Health and Intelligent Health Systems

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

Unit I: Digital Health Ecosystem

Digital health, telehealth, mobile health, remote care, patient portals, digital therapeutics and health platforms.

Unit II: Public Health Systems

Public health principles, prevention, surveillance, immunization, population health, health indicators and health programmes.

Unit III: Intelligent Health Systems

AI in healthcare, clinical decision support, hospital intelligence, public health intelligence, medical devices and connected care.

Unit IV: Ethics, Patient Safety and Responsible Health Technology

Privacy, consent, bias, explainability, patient safety, health equity, digital divide and responsible innovation.

Textbooks / References

1. Eric Topol, *The Patient Will See You Now*, Basic Books.
2. Robert Wachter, *The Digital Doctor*, McGraw-Hill.
3. Rifat Latifi, *The Modern Hospital*, Springer.
4. Lawrence O. Gostin, *Public Health Law*, University of California Press.
5. Edward H. Shortliffe and James J. Cimino, *Biomedical Informatics*, Springer.

GFT-MIHBO4101: Major Track Studio B-I — Human Health Systems, EHR and Clinical Data Practice Intensive

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

Unit I: Medical Terminology Practice

Clinical vocabulary, abbreviations, diagnosis terms, procedure terms and documentation interpretation.

Unit II: Patient Journey and Workflow Mapping

OPD, IPD, emergency, lab, radiology, pharmacy, discharge and follow-up workflow mapping.

Unit III: EHR and Clinical Data Practice

Patient table, encounter table, observation table, lab table, medication table and FHIR-style representation.

Unit IV: Health Systems Portfolio

Workflow maps, EHR data models, clinical data interpretation sheets, dashboard mock-ups and portfolio review.

Textbooks / References

1. Davi-Ellen Chabner, *Medical Terminology: A Short Course*, Elsevier.
2. Robert E. Hoyt and Ann K. Yoshihashi, *Health Informatics: Practical Guide*, Lulu Press.
3. Edward H. Shortliffe and James J. Cimino, *Biomedical Informatics*, Springer.
4. Tim Benson and Grahame Grieve, *Principles of Health Interoperability*, Springer.
5. Robert Wachter, *The Digital Doctor*, McGraw-Hill.

Semester II — Track B

AI and Computational Elevation for Health Systems Learners

GFT-MIHB4201: Python for Health Data Science and Applied Analytics

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

Unit I: Python for Health Data

Python notebooks, data types, functions, files, CSV processing and health data tables.

Unit II: Data Handling with Python

NumPy, pandas, cleaning, filtering, grouping, aggregation, missing values and transformation.

Unit III: Exploratory Health Analytics

Descriptive statistics, cohort analysis, lab trend analysis, public health data analysis and visualization.

Unit IV: Reproducible Health Data Reports

Notebooks, charts, dashboards, markdown reports, evidence explanation and portfolio-ready analytics.

Textbooks / References

1. Wes McKinney, *Python for Data Analysis*, O'Reilly Media.
2. Jake VanderPlas, *Python Data Science Handbook*, O'Reilly Media.
3. Allen B. Downey, *Think Python*, O'Reilly Media.
4. David Spiegelhalter, *The Art of Statistics*, Pelican.
5. Kieran Healy, *Data Visualization: A Practical Introduction*, Princeton University Press.

GFT-MIHB4202: Machine Learning for Clinical and Public Health Applications

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

Unit I: ML Foundations for Health Applications

ML workflow, features, labels, training, validation, testing, health datasets and problem formulation.

Unit II: Clinical Prediction Models

Regression, classification, logistic regression, decision trees, ensembles and clinical risk prediction.

Unit III: Public Health and Hospital ML Applications

Disease surveillance, patient stratification, hospital operations, outbreak signals and resource prediction.

Unit IV: Evaluation, Explainability and Safety

Sensitivity, specificity, AUROC, calibration, bias, explainability, false positives, false negatives and patient safety.

Textbooks / References

1. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly Media.
2. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer.
3. Gareth James et al., *An Introduction to Statistical Learning*, Springer.
4. Eric Topol, *Deep Medicine*, Basic Books.
5. David W. Hosmer et al., *Applied Logistic Regression*, Wiley.

GFT-MIHB4203: Health Data Engineering, FHIR, HL7 and Interoperability Foundations

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

Unit I: Health Data Engineering Foundations

Health data sources, ingestion, cleaning, validation, transformation, metadata and pipeline thinking.

Unit II: FHIR, HL7 and Health Information Exchange

FHIR resources, HL7 orientation, interoperability problems, health record exchange and system integration.

Unit III: APIs and Data Services for Health Platforms

REST APIs, JSON, authentication orientation, data services, API documentation and integration testing.

Unit IV: Applied Interoperability Practice

FHIR-style patient, encounter, observation and medication resources; pipeline notebooks and exchange-ready data models.

Textbooks / References

1. Tim Benson and Grahame Grieve, *Principles of Health Interoperability*, Springer.
2. Joe Reis and Matt Housley, *Fundamentals of Data Engineering*, O'Reilly Media.
3. Martin Kleppmann, *Designing Data-Intensive Applications*, O'Reilly Media.
4. Edward H. Shortliffe and James J. Cimino, *Biomedical Informatics*, Springer.
5. Robert E. Hoyt and Ann K. Yoshihashi, *Health Informatics: Practical Guide*, Lulu Press.

GFT-MIHB4204: Clinical AI, Decision Support and Model Evaluation Foundations

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

Unit I: Clinical AI Foundations

Clinical AI use cases, diagnostic support, risk prediction, triage support, clinical workflow integration and human oversight.

Unit II: Clinical Decision Support Systems

Rule-based CDS, ML-based CDS, alerts, recommendations, care pathways, usability and clinician trust.

Unit III: Model Evaluation and Clinical Validation Basics

Sensitivity, specificity, predictive values, AUROC, calibration, subgroup performance and retrospective validation.

Unit IV: Explainability, Safety and Governance

Explainable AI, clinical accountability, bias, patient safety, model cards, auditability and deployment caution.

Textbooks / References

1. Edward H. Shortliffe and James J. Cimino, *Biomedical Informatics*, Springer.
2. Eric Topol, *Deep Medicine*, Basic Books.
3. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, Pearson.
4. Virginia Dignum, *Responsible Artificial Intelligence*, Springer.
5. David W. Hosmer et al., *Applied Logistic Regression*, Wiley.

GFT-MIHB4205: Applied Health Systems Lab I — EHR, Analytics and Clinical AI Prototype

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

Unit I: EHR Data Model and Dataset Preparation

Patient, encounter, observation, lab and medication data modelling; data cleaning and cohort construction.

Unit II: Health Analytics Dashboard

Descriptive analytics, trends, cohort summaries, public health indicators and hospital dashboard components.

Unit III: Basic Clinical AI Prototype

Risk model, triage rule, prediction model, model evaluation and explainability note.

Unit IV: Prototype Demonstration and Portfolio

Prototype demo, technical report, clinical relevance note, safety reflection and portfolio evidence.

Textbooks / References

1. Edward H. Shortliffe and James J. Cimino, *Biomedical Informatics*, Springer.
2. Wes McKinney, *Python for Data Analysis*, O'Reilly Media.
3. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly Media.
4. Chip Huyen, *Designing Machine Learning Systems*, O'Reilly Media.
5. Kieran Healy, *Data Visualization: A Practical Introduction*, Princeton University Press.

GFT-MIHBO4201: Major Track Studio B-II — Health Data, Clinical Validation and Digital Health Practice Intensive

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

Unit I: Health Data Interpretation Practice

Clinical variables, lab reports, diagnosis records, medication records, imaging reports and patient timeline interpretation.

Unit II: EHR and Digital Health Workflow Practice

EHR workflow, FHIR-style resources, dashboard mock-up, API orientation and health platform workflow mapping.

Unit III: Clinical Evaluation Practice

Sensitivity, specificity, AUROC, calibration, bias analysis, subgroup review and validation report structure.

Unit IV: Practice Portfolio

Clinical data interpretation file, EHR workflow model, evaluation notebook, dashboard prototype and portfolio review.

Textbooks / References

1. Trisha Greenhalgh, *How to Read a Paper*, Wiley-Blackwell.
2. Edward H. Shortliffe and James J. Cimino, *Biomedical Informatics*, Springer.
3. Tim Benson and Grahame Grieve, *Principles of Health Interoperability*, Springer.
4. Wayne W. Daniel and Chad L. Cross, *Biostatistics*, Wiley.
5. Robert Wachter, *The Digital Doctor*, McGraw-Hill.

PART C

Common Summer Term

Merger-Readiness Block for Track A and Track B

GFT-MIHO4S01: Major Track Studio III — Medical AI, Clinical NLP, Imaging AI and GenAI Foundations

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

Unit I: Medical AI Practice Orientation

Clinical AI use cases, prediction models, diagnostic AI, model evaluation and health AI workflow integration.

Unit II: Clinical NLP Foundations

Clinical notes, discharge summaries, entity extraction, coding support, summarization, medical text classification and hallucination risks.

Unit III: Medical Imaging AI Foundations

DICOM orientation, PACS workflow, image classification, segmentation, detection, explainability and reader-study orientation.

Unit IV: Medical GenAI and Health AI Agents

Medical LLMs, RAG, health knowledge systems, AI agents, safety evaluation, prompt risks and responsible GenAI use.

Textbooks / References

1. Jurafsky and Martin, *Speech and Language Processing*, Pearson / Draft Online Edition.
2. Richard Szeliski, *Computer Vision: Algorithms and Applications*, Springer.
3. Ian Goodfellow, Yoshua Bengio and Aaron Courville, *Deep Learning*, MIT Press.
4. Eric Topol, *Deep Medicine*, Basic Books.
5. Edward H. Shortliffe and James J. Cimino, *Biomedical Informatics*, Springer.

GFT-MIHO4S02: Major Track Studio IV — Research, Product Thinking, Clinical Validation and Minor Capstone Definition

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

Unit I: Health-Tech Research Reading

Research papers, literature review, clinical context, evidence mapping, research gap and problem framing.

Unit II: Health Product Thinking

Stakeholders, patient needs, clinician needs, product requirements, workflow fit, feasibility, risk and value proposition.

Unit III: Clinical Validation and Governance Planning

Dataset plan, evaluation metrics, validation strategy, ethics, privacy, safety and regulatory-style documentation orientation.

Unit IV: Minor Capstone Proposal

Problem statement, solution concept, architecture, dataset plan, validation plan, presentation and portfolio documentation.

Textbooks / References

1. Wayne C. Booth, Gregory G. Colomb and Joseph M. Williams, *The Craft of Research*, University of Chicago Press.
2. Creswell and Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, SAGE.
3. Trisha Greenhalgh, *How to Read a Paper*, Wiley-Blackwell.
4. Marty Cagan, *Inspired: How to Create Tech Products Customers Love*, Wiley.
5. Eric Ries, *The Lean Startup*, Crown Business.

PART D

Year II Common Merger Stage

Same as Integrated M.Sc. Intelligent Health Systems Semester IX and X

Semester III

Specialization, Clinical Validation, Scalable Health Platforms and Capstone Definition

GFT-IHS5101: Specialization Elective I

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

Unit I: Specialization Foundations

Concepts, terminology, application landscape and professional relevance of the selected health-tech specialization.

Unit II: Core Methods and Data Types

Specialization-specific data, algorithms, models, workflows, standards and implementation approaches.

Unit III: Applications and Case Studies

Clinical, hospital, public health, biomedical, digital health or medical device case studies depending on specialization.

Unit IV: Emerging Directions and Responsible Practice

Recent developments, limitations, validation needs, safety, ethics, regulation and specialization portfolio tasks.

Textbooks / References

1. Edward H. Shortliffe and James J. Cimino, *Biomedical Informatics*, Springer.
2. Eric Topol, *Deep Medicine*, Basic Books.
3. Ian Goodfellow, Yoshua Bengio and Aaron Courville, *Deep Learning*, MIT Press.
4. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, Pearson.
5. Chip Huyen, *Designing Machine Learning Systems*, O'Reilly Media.

GFT-IHS5102: Specialization Elective II

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

Unit I: Advanced Specialization Concepts

Advanced theory, workflows, datasets, standards and clinical or health-system context of the chosen track.

Unit II: Tools, Platforms and Architectures

Software frameworks, platform design, data pipelines, model pipelines, health APIs and deployment workflows.

Unit III: Validation and Quality

Performance metrics, clinical validation, external validation, subgroup analysis, robustness, explainability and quality control.

Unit IV: Research and Industry Applications

Recent papers, global company use cases, product opportunities, limitations and future direction mapping.

Textbooks / References

1. Kevin P. Murphy, *Probabilistic Machine Learning: An Introduction*, MIT Press.
2. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly Media.
3. Tim Benson and Grahame Grieve, *Principles of Health Interoperability*, Springer.
4. Richard Szeliski, *Computer Vision: Algorithms and Applications*, Springer.
5. Jurafsky and Martin, *Speech and Language Processing*, Pearson / Draft Online Edition.

GFT-IHS5103: Clinical Validation, Real-World Evidence and Health AI Evaluation

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

Unit I: Clinical Validation Foundations

Clinical utility, diagnostic performance, retrospective validation, prospective validation and validation study design.

Unit II: Model Evaluation Metrics

Sensitivity, specificity, PPV, NPV, AUROC, AUPRC, calibration, decision curves and clinical threshold selection.

Unit III: Real-World Evidence and Safety Monitoring

Real-world data, external validation, subgroup performance, bias testing, drift monitoring and post-deployment surveillance.

Unit IV: Health AI Evaluation Documentation

Validation reports, model cards, dataset sheets, safety notes, audit trails, limitations and regulatory-style evidence.

Textbooks / References

1. David W. Hosmer, Stanley Lemeshow and Rodney X. Sturdivant, *Applied Logistic Regression*, Wiley.
2. Trevor Hastie, Robert Tibshirani and Jerome Friedman, *The Elements of Statistical Learning*, Springer.
3. Wayne W. Daniel and Chad L. Cross, *Biostatistics*, Wiley.
4. Trisha Greenhalgh, *How to Read a Paper*, Wiley-Blackwell.
5. Eric Topol, *Deep Medicine*, Basic Books.

GFT-IHS5104: Scalable Health Platforms, Cloud Architecture and Interoperability

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

Unit I: Scalable Health Platform Architecture

Health platform components, data layer, service layer, model layer, application layer, APIs and workflow architecture.

Unit II: Health Data Engineering and Interoperability

FHIR, HL7, DICOM, health information exchange, terminology services, metadata and data governance.

Unit III: Cloud, Deployment and Security

Cloud architecture, containers, serverless orientation, API deployment, cybersecurity, privacy and access control.

Unit IV: Health AI Platform Operations

MLOps, monitoring, model versioning, drift detection, auditability, reliability and governance for health AI platforms.

Textbooks / References

1. Martin Kleppmann, *Designing Data-Intensive Applications*, O'Reilly Media.
2. Chip Huyen, *Designing Machine Learning Systems*, O'Reilly Media.
3. Tim Benson and Grahame Grieve, *Principles of Health Interoperability*, Springer.
4. Mark Treveil et al., *Introducing MLOps*, O'Reilly Media.
5. Joe Reis and Matt Housley, *Fundamentals of Data Engineering*, O'Reilly Media.

GFT-IHS5105: Capstone Phase I — Industry / Hospital / Research Product Definition

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

Unit I: Capstone Problem Discovery

Hospital, clinical, public health, biomedical, industry or digital health problem identification and stakeholder mapping.

Unit II: Literature, Dataset and Feasibility Study

Research review, dataset plan, feasibility analysis, ethics, privacy, safety and risk identification.

Unit III: Solution Architecture and Validation Plan

System design, model plan, product requirement, evaluation metrics, clinical validation and milestone planning.

Unit IV: Proposal Review and Portfolio Evidence

Capstone proposal, presentation, mentor review, iteration, project plan and portfolio documentation.

Textbooks / References

1. Wayne C. Booth, Gregory G. Colomb and Joseph M. Williams, *The Craft of Research*, University of Chicago Press.
2. Trisha Greenhalgh, *How to Read a Paper*, Wiley-Blackwell.
3. Chip Huyen, *Designing Machine Learning Systems*, O'Reilly Media.
4. Marty Cagan, *Inspired: How to Create Tech Products Customers Love*, Wiley.
5. Edward H. Shortliffe and James J. Cimino, *Biomedical Informatics*, Springer.

GFT-MIHO5101: Major Track Studio V — Health-Tech Specialization Practice and Minor Capstone Phase I

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

Unit I: Specialization Practice Orientation

Track-specific problem selection, dataset identification, health workflow mapping and technical stack selection.

Unit II: Advanced Implementation Practice

Model implementation, data pipeline, dashboard/API component, platform module or health AI workflow development.

Unit III: Minor Capstone Phase I

Prototype design, development milestone, validation plan, safety reflection and mentor review.

Unit IV: Practice Evidence and Technical Review

Code repository, technical documentation, model card, demo, health relevance note and portfolio review.

Textbooks / References

1. Chip Huyen, *Designing Machine Learning Systems*, O'Reilly Media.
2. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly Media.
3. Edward H. Shortliffe and James J. Cimino, *Biomedical Informatics*, Springer.
4. Tim Benson and Grahame Grieve, *Principles of Health Interoperability*, Springer.
5. Ian Goodfellow, Yoshua Bengio and Aaron Courville, *Deep Learning*, MIT Press.

Semester IV

Governance, Global Compliance and Capstone Completion

GFT-IHS5201: Specialization Elective III

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

Unit I: Specialization Consolidation

Advanced specialization concepts, current challenges, professional applications and research directions.

Unit II: Advanced Health-Tech Systems

Complex applications, health product systems, clinical workflows, deployment models and real-world constraints.

Unit III: Validation, Governance and Industry Readiness

Clinical validation, safety, explainability, monitoring, governance, regulation and product quality.

Unit IV: Specialization Portfolio and Future Directions

Portfolio artifact, paper/product review, innovation possibilities, specialization roadmap and professional presentation.

Textbooks / References

1. Eric Topol, *Deep Medicine*, Basic Books.
2. Kevin P. Murphy, *Probabilistic Machine Learning: Advanced Topics*, MIT Press.
3. Chip Huyen, *Designing Machine Learning Systems*, O'Reilly Media.
4. Richard Szeliski, *Computer Vision: Algorithms and Applications*, Springer.
5. Jurafsky and Martin, *Speech and Language Processing*, Pearson / Draft Online Edition.

GFT-IHS5202: Health AI Governance, Regulation, Quality and Global Compliance

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

Unit I: Responsible Health AI Foundations

Bias, fairness, explainability, accountability, patient safety, privacy, consent and human oversight.

Unit II: Regulation and Quality Orientation

Software as a Medical Device, AI-enabled medical devices, FDA, CE/MDR, CDSCO orientation, ISO 13485, IEC 62304 and ISO 14971 orientation.

Unit III: Health AI Risk and Governance

Risk registers, model cards, auditability, cybersecurity, post-market monitoring, drift, incident reporting and governance lifecycle.

Unit IV: Global Compliance and Future Health-Tech Leadership

Clinical accountability, global product readiness, ethical leadership, institutional governance and future health technology policy.

Textbooks / References

1. Virginia Dignum, *Responsible Artificial Intelligence*, Springer.
2. Luciano Floridi, *The Ethics of Artificial Intelligence*, Oxford University Press.
3. Eric Topol, *Deep Medicine*, Basic Books.
4. Robert Wachter, *The Digital Doctor*, McGraw-Hill.
5. Cathy O'Neil, *Weapons of Math Destruction*, Crown.

GFT-IHS5203: Capstone Phase II — Implementation, Validation, Dissertation and Product Portfolio

L:T:P:0:2:6
Credits: 8

Unit I: Capstone Implementation

System development, data pipeline, model/product implementation, health workflow integration and technical documentation.

Unit II: Validation and Evaluation

Clinical/technical validation, performance analysis, error analysis, usability review, risk assessment and safety evaluation.

Unit III: Dissertation and Regulatory-Style Documentation

Dissertation writing, methodology, results, discussion, limitations, ethics, privacy and regulatory-style technical file.

Unit IV: Final Demonstration and Viva

Final demo, product portfolio, presentation, viva voce, deployment note, future work and professional portfolio publication.

Textbooks / References

1. Wayne C. Booth, Gregory G. Colomb and Joseph M. Williams, *The Craft of Research*, University of Chicago Press.
2. Creswell and Creswell, *Research Design*, SAGE.
3. Chip Huyen, *Designing Machine Learning Systems*, O'Reilly Media.
4. Trisha Greenhalgh, *How to Read a Paper*, Wiley-Blackwell.
5. Marty Cagan, *Inspired: How to Create Tech Products Customers Love*, Wiley.

GFT-MIHO5201: Major Track Studio VI — Health-Tech Professional Portfolio, Minor Capstone Phase II and Deployment Readiness

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

Unit I: Minor Capstone Completion

Final implementation, testing, validation, refinement and evidence consolidation.

Unit II: Deployment and Product Readiness

Demo environment, deployment workflow, user guide, model card, product note and health safety documentation.

Unit III: Professional Health-Tech Portfolio

Portfolio site, Git repository, technical resume, case study, project page, presentation deck and professional narrative.

Unit IV: Review, Viva and Career Readiness

Portfolio review, technical viva, mock presentation, product/research note and future development roadmap.

Textbooks / References

1. Chip Huyen, *Designing Machine Learning Systems*, O'Reilly Media
2. Emmanuel Ameisen, *Building Machine Learning Powered Applications*, O'Reilly Media.
3. Marty Cagan, *Inspired: How to Create Tech Products Customers Love*, Wiley
4. Austin Kleon, *Show Your Work!*, Workman Publishing.
5. Eric Topol, *Deep Medicine*, Basic Books.

