First Year Outline Syllabus
For Integrated M.Sc. in
Artificial Intelligence, Data Science and Intelligent Systems

Pre-Semester Courses

Bridge to Future Technology Education

GFT-PS1101: Mathematical Readiness for AI and Data

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

Unit I: Number Sense and Algebraic Thinking

Numbers, variables, expressions, fractions, ratios, percentages, powers, roots, equations, inequalities, estimation and approximation.

Unit II: Functions, Graphs and Patterns

Functions, input-output relationships, linear and non-linear patterns, graphs, slope, rate of change, sequences and introductory modelling.

Unit III: Vectors, Matrices and Representation

Coordinates, vectors, vector operations, distance, similarity, matrices, matrix representation of data and simple transformations.

Unit IV: Counting, Probability and Data Thinking

Counting principles, events, probability, averages, variation, distributions, uncertainty, correlation and causation.

Textbooks / References

1. Gilbert Strang, *Introduction to Linear Algebra*, Wellesley-Cambridge Press.
2. Eric Lehman, F. Thomson Leighton and Albert R. Meyer, *Mathematics for Computer Science*, MIT OpenCourseWare.
3. Joseph K. Blitzstein and Jessica Hwang, *Introduction to Probability*, CRC Press.
4. David C. Lay, Steven R. Lay and Judi J. McDonald, *Linear Algebra and Its Applications*, Pearson.
5. Sheldon M. Ross, *A First Course in Probability*, Pearson.

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, algorithmic thinking and stepwise reasoning.

Unit II: Algorithms, Flowcharts and Pseudocode

Algorithm design, flowchart symbols, pseudocode writing, sequence, selection, iteration and dry-run methods.

Unit III: Problem-Solving Strategies

Brute force, divide and conquer intuition, search, sorting intuition, optimization thinking, constraints and edge cases.

Unit IV: Computational Problem Practice

Everyday computational problems, logic puzzles, tabular reasoning, simple automation ideas and problem-to-program transition.

Textbooks / References

1. David D. Riley and Kenny A. Hunt, *Computational Thinking for the Modern Problem Solver*, CRC Press.
2. Jeannette M. Wing, *Computational Thinking*, Communications of the ACM.
3. John V. Guttag, *Introduction to Computation and Programming Using Python*, MIT Press.
4. Allen B. Downey, *Think Python*, O'Reilly Media.
5. Seymour Papert, *Mindstorms: Children, Computers, and Powerful Ideas*, Basic Books.

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

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

Unit I: Digital Academic Readiness

Digital identity, learning platforms, file management, academic communication, online safety and responsible digital behaviour.

Unit II: Information Literacy and Knowledge Discovery

Search strategies, source evaluation, citation awareness, plagiarism, academic integrity and structured note-making.

Unit III: AI Tools for Learning

Introduction to AI assistants, prompt formulation, AI-supported learning, AI limitations, verification, bias and responsible use.

Unit IV: Academic Productivity and Portfolio Readiness

Digital documents, spreadsheets, presentations, collaborative tools, learning portfolio, reflective logs and evidence-based learning.

Textbooks / References

1. Paul Gilster, *Digital Literacy*, Wiley.
2. 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.
3. Barbara Oakley and Terrence Sejnowski, *Learning How to Learn*, TarcherPerigee.
4. Joseph M. Williams and Joseph Bizup, *Style: Lessons in Clarity and Grace*, Pearson.
5. Ethan Mollick, *Co-Intelligence: Living and Working with AI*, Portfolio.

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 environments, input, output, variables, expressions and basic execution flow.

Unit II: Control Structures

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

Unit III: Functions and Modular Thinking

Functions, parameters, return values, reuse, simple debugging, tracing and error correction.

Unit IV: Beginner Programming Practice

Micro-problems, pattern problems, number problems, string basics, list basics and auto-evaluated programming 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, Computing and AI

GFT-AI1101: Scientific Thinking and Systems Orientation

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

Unit I: Nature of Scientific Thinking

Observation, questioning, hypothesis, evidence, experiment, falsifiability, explanation and scientific attitude.

Unit II: Logical and Critical Reasoning

Arguments, assumptions, claims, evidence, fallacies, bias, causality, uncertainty and reflective reasoning.

Unit III: Systems Thinking Foundations

Systems, components, boundaries, relationships, feedback loops, emergence, complexity and system behaviour.

Unit IV: Science, Technology and Intelligent Systems

Scientific thinking in AI, data-driven inquiry, socio-technical systems, ethics, human impact and future technology orientation.

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. Peter M. Senge, *The Fifth Discipline*, Currency.
5. Daniel Kahneman, *Thinking, Fast and Slow*, Farrar, Straus and Giroux.

GFT-AI1102: Python Programming for 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: Data Structures in Python

Strings, lists, tuples, dictionaries, sets, iteration over collections and simple data manipulation.

Unit IV: Files, Modules and Problem Solving

File handling, modules, exceptions, basic libraries, debugging, testing and structured problem-solving 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. Mark Lutz, *Learning Python*, O'Reilly Media.

GFT-AI1103: Foundations of Data Literacy and Digital Systems

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

Unit I: Data Literacy Foundations

Data, information, knowledge, data types, variables, measurement, datasets, data quality and data ethics.

Unit II: Data Representation and Visualization

Tables, charts, graphs, distributions, dashboards, storytelling with data and misleading visualizations.

Unit III: Digital Systems Foundations

Hardware, software, operating systems, networks, internet, cloud, databases and digital platforms.

Unit IV: Data in Intelligent Digital Systems

Digital workflows, data pipelines, sensors, logs, user data, intelligent applications, privacy and responsible data use.

Textbooks / References

1. David Spiegelhalter, *The Art of Statistics: Learning from Data*, Pelican.
2. Alberto Cairo, *The Truthful Art: Data, Charts, and Maps for Communication*, New Riders.
3. Kieran Healy, *Data Visualization: A Practical Introduction*, Princeton University Press.
4. Brian W. Kernighan, *Understanding the Digital World*, Princeton University Press.
5. J. Glenn Brookshear and Dennis Brylow, *Computer Science: An Overview*, Pearson.

Semester II Courses
Mathematics, Programming and Data Foundations

GFT-AI1201: Linear Algebra and Matrix Methods for AI

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

Unit I: Systems of Linear Equations and Matrices

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

Unit II: Vectors, Vector Spaces and Subspaces

Vectors, span, linear independence, basis, dimension, subspaces, column space, null space and rank.

Unit III: Orthogonality, Projections and Least Squares

Dot product, norm, distance, orthogonality, projections, Gram-Schmidt intuition and least squares approximation.

Unit IV: Eigenvalues, Eigenvectors and AI Applications

Eigenvalues, eigenvectors, diagonalization intuition, principal component analysis, feature spaces and matrix methods in 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. Stephen H. Friedberg, Arnold J. Insel and Lawrence E. Spence, *Linear Algebra*, Pearson.
4. Howard Anton and Chris Rorres, *Elementary Linear Algebra*, Wiley.
5. Marc Peter Deisenroth, A. Aldo Faisal and Cheng Soon Ong, *Mathematics for Machine Learning*, Cambridge University Press.

GFT-AI1202: Probability and Statistics for Data Science

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

Unit I: Descriptive Statistics and Data Distributions

Data types, sampling, frequency distributions, mean, median, mode, variance, standard deviation and visualization.

Unit II: Probability Foundations

Sample spaces, events, probability rules, conditional probability, independence, Bayes' theorem and counting methods.

Unit III: Random Variables and Probability Distributions

Discrete and continuous random variables, expectation, variance, Bernoulli, binomial, Poisson and normal distributions.

Unit IV: Statistical Inference for Data Science

Sampling distributions, estimation, confidence intervals, hypothesis testing, correlation, regression intuition and statistical reasoning.

Textbooks / References

1. Joseph K. Blitzstein and Jessica Hwang, *Introduction to Probability*, CRC Press.
2. Sheldon M. Ross, *A First Course in Probability*, Pearson.
3. David S. Moore, George P. McCabe and Bruce A. Craig, *Introduction to the Practice of Statistics*, W. H. Freeman.
4. Larry Wasserman, *All of Statistics: A Concise Course in Statistical Inference*, Springer.
5. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani and Jonathan Taylor, *An Introduction to Statistical Learning*, Springer.

GFT-AI1203: Programming Structures and Algorithmic Thinking

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

Unit I: Structured Programming and Problem Decomposition

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

Unit II: Core Data Structures for Problem Solving

Arrays/lists, strings, stacks, queues, dictionaries/maps, sets and simple linked structure intuition.

Unit III: Algorithmic Thinking

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

Unit IV: Applied Programming Practice

Problem patterns, edge cases, testing, input-output handling, code quality and auto-evaluated algorithmic 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-AI1204: Data Handling, Visualization and Exploratory Analysis

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

Unit I: Data Handling Foundations

Datasets, data formats, CSV, JSON, spreadsheets, data loading, cleaning, missing values and data transformation.

Unit II: Exploratory Data Analysis

Summary statistics, grouping, aggregation, filtering, sorting, outliers, distributions and relationships.

Unit III: Data Visualization

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

Unit IV: Applied Data Analysis Practice

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

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. Tukey, John W., *Exploratory Data Analysis*, Addison-Wesley.
5. Alberto Cairo, *The Truthful Art: Data, Charts, and Maps for Communication*, New Riders.

GFT-AI1205: Mini Project I — Data and Problem Discovery

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

Unit I: Problem Discovery and Context Understanding

Problem identification, stakeholder understanding, context mapping, observation, questioning and problem framing.

Unit II: Data Discovery and Collection

Data sources, primary and secondary data, surveys, observation sheets, open datasets, data ethics and consent awareness.

Unit III: Data Preparation and Exploratory Analysis

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

Unit IV: Project Documentation and Presentation

Problem statement, methodology, analysis, findings, limitations, presentation, portfolio evidence and reflective learning.

Textbooks / References

1. Cathy O'Neil and Rachel Schutt, *Doing Data Science*, O'Reilly Media.
2. Joel Grus, *Data Science from Scratch*, O'Reilly Media.
3. Foster Provost and Tom Fawcett, *Data Science for Business*, O'Reilly Media.
4. Hadley Wickham and Garrett Grolemund, *R for Data Science*, O'Reilly Media.
5. Kieran Healy, *Data Visualization: A Practical Introduction*, Princeton University Press.

