Ⅰ.3.4.C (*Detour)* Syllabus

Post-B.Sc. M.Sc. in Artificial Intelligence, Data Science and Intelligent Systems

With Compulsory Add-on Major Track Credits

Semester I
Foundation Elevation for AI, Data Science and Intelligent Systems

GFT-MAI4101: Scientific Computing and Pythonic Problem Solving

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

Unit I: Scientific Computing Foundations

Python environment, computational notebooks, variables, expressions, functions, control flow, numerical thinking and reproducible computation.

Unit II: Python for Data and Scientific Problems

Lists, tuples, dictionaries, arrays, file handling, tabular data, NumPy foundations and structured problem-solving.

Unit III: Numerical and Computational Problem Solving

Approximation, iteration, simulation intuition, plotting, error handling, debugging, testing and computational experiments.

Unit IV: Applied Scientific Programming Practice

Data-oriented programs, mathematical computation, visualization, reusable functions, problem notebooks and portfolio-ready coding tasks.

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. Hans Petter Langtangen, *A Primer on Scientific Programming with Python*, Springer.
4. Wes McKinney, *Python for Data Analysis*, O'Reilly Media.
5. Jake VanderPlas, *Python Data Science Handbook*, O'Reilly Media.

GFT-MAI4102: Linear Algebra, Probability and Statistics for AI

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

Unit I: Linear Algebra for AI

Vectors, matrices, systems of equations, matrix operations, rank, basis, span, linear independence and transformations.

Unit II: Matrix Methods and Model Geometry

Dot product, norms, distance, projections, least squares, eigenvalues, eigenvectors, dimensionality reduction and PCA intuition.

Unit III: Probability Foundations

Events, conditional probability, Bayes' theorem, random variables, expectation, variance and common probability distributions.

Unit IV: Statistics for AI and Data Science

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

Textbooks / References

1. Gilbert Strang, *Introduction to Linear Algebra*, Wellesley-Cambridge Press.
2. Marc Peter Deisenroth, A. Aldo Faisal and Cheng Soon Ong, *Mathematics for Machine Learning*, Cambridge University Press.
3. Joseph K. Blitzstein and Jessica Hwang, *Introduction to Probability*, CRC Press.
4. Larry Wasserman, *All of Statistics: A Concise Course in Statistical Inference*, Springer.
5. David C. Lay, Steven R. Lay and Judi J. McDonald, *Linear Algebra and Its Applications*, Pearson.

GFT-MAI4103: Data Structures, Algorithms and Computational Thinking

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

Unit I: Computational Thinking and Algorithmic Foundations

Problem decomposition, abstraction, algorithm design, correctness, tracing, recursion and computational efficiency.

Unit II: Linear and Non-Linear Data Structures

Arrays, lists, stacks, queues, linked structures, trees, heaps, hash tables, graphs and their applications.

Unit III: Core Algorithms and Complexity

Searching, sorting, recursion, divide and conquer, greedy methods, dynamic programming intuition and complexity analysis.

Unit IV: Applied Algorithmic Problem Solving

Problem patterns, edge cases, testing, optimization, algorithm selection and auto-evaluated programming practice.

Textbooks / References

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

GFT-MAI4104: Database Systems, Data Modelling and Data Handling

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

Unit I: Database Foundations and Data Models

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

Unit II: SQL and Structured Data Management

SQL queries, joins, aggregation, subqueries, views, indexing intuition, transactions and query design.

Unit III: Data Handling and Preparation

Data formats, CSV, JSON, data cleaning, missing values, data transformation, validation and structured data pipelines.

Unit IV: Data Modelling for Applications

Database-backed applications, analytical data models, NoSQL orientation, data governance and responsible data handling.

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. Raghu Ramakrishnan and Johannes Gehrke, *Database Management Systems*, McGraw-Hill.
4. Wes McKinney, *Python for Data Analysis*, O'Reilly Media.
5. Cathy O'Neil and Rachel Schutt, *Doing Data Science*, O'Reilly Media.

GFT-MAI4105: Foundations of Artificial Intelligence and Intelligent Problem Solving

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

Unit I: Foundations and History of AI

Meaning of intelligence, AI evolution, agents, environments, rationality, problem formulation and AI application landscape.

Unit II: Search and Problem Solving

State spaces, uninformed search, informed search, heuristic search, constraint satisfaction and game search intuition.

Unit III: Knowledge, Reasoning and Decision-Making

Logic, knowledge representation, inference, uncertainty, decision-making, planning and rule-based systems.

Unit IV: Learning and Intelligent Systems Orientation

Machine learning overview, intelligent agents, perception, language, robotics, responsible AI and human-AI systems.

Textbooks / References

1. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, Pearson.
2. Elaine Rich, Kevin Knight and Shivashankar B. Nair, *Artificial Intelligence*, McGraw-Hill.
3. Nils J. Nilsson, *Artificial Intelligence: A New Synthesis*, Morgan Kaufmann.
4. David L. Poole and Alan K. Mackworth, *Artificial Intelligence: Foundations of Computational Agents*, Cambridge University Press.
5. Melanie Mitchell, *Artificial Intelligence: A Guide for Thinking Humans*, Farrar, Straus and Giroux.

GFT-MAO4101: Major Track Studio I — Programming, Data Structures and AI Practice Intensive

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

Unit I: Python and Programming Practice

Structured coding, functions, debugging, input-output, modular programming and programming fluency tasks.

Unit II: Data Structures Practice

Lists, dictionaries, stacks, queues, trees, graphs, hashing and implementation-oriented exercises.

Unit III: Algorithmic and AI Problem Practice

Search, sorting, recursion, heuristics, constraint problems and simple AI problem-solving tasks.

Unit IV: Portfolio Practice and Review

Integrated coding assignments, auto-evaluated tasks, code review, documentation and technical portfolio evidence.

Textbooks / References

1. Allen B. Downey, *Think Python*, O'Reilly Media.
2. Bradley N. Miller and David L. Ranum, *Problem Solving with Algorithms and Data Structures Using Python*, Franklin, Beedle & Associates.
3. Thomas H. Cormen et al., *Introduction to Algorithms*, MIT Press.
4. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, Pearson.
5. Steven S. Skiena, *The Algorithm Design Manual*, Springer.

Semester II

Machine Learning, Deep Learning, Data Engineering and Intelligent Applications

GFT-MAI4201: Machine Learning and Model Evaluation

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

Unit I: Machine Learning Foundations

Supervised, unsupervised and reinforcement learning overview, datasets, features, labels, training, validation and testing.

Unit II: Supervised Learning Models

Linear regression, logistic regression, decision trees, ensemble methods, support vector machines and model interpretation.

Unit III: Unsupervised Learning and Feature Learning

Clustering, dimensionality reduction, anomaly detection, feature scaling, representation and exploratory model building.

Unit IV: Model Evaluation and Improvement

Metrics, cross-validation, bias-variance, overfitting, hyperparameter tuning, fairness, explainability and model reporting.

Textbooks / References

1. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer.
2. Kevin P. Murphy, *Machine Learning: A Probabilistic Perspective*, MIT Press.
3. Trevor Hastie, Robert Tibshirani and Jerome Friedman, *The Elements of Statistical Learning*, Springer.
4. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly Media.
5. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani and Jonathan Taylor, *An Introduction to Statistical Learning*, Springer.

GFT-MAI4202: Deep Learning and Representation Learning

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

Feedforward networks, convolutional neural networks, recurrent networks, sequence models, embeddings and attention intuition.

Unit III: Representation Learning

Feature learning, autoencoders, transfer learning, pretrained models, latent spaces and representation quality.

Unit IV: Deep Learning Practice and Evaluation

Training pipelines, regularization, model tuning, evaluation, interpretability, ethics and responsible deep learning.

Textbooks / References

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

GFT-MAI4203: Data Engineering, Pipelines and Cloud Foundations

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

Unit I: Data Engineering Foundations

Data sources, ingestion, storage, transformation, data quality, batch processing and data pipeline thinking.

Unit II: Data Pipelines and Workflow Design

ETL, ELT, orchestration, validation, logging, monitoring, metadata, data lineage and reproducible workflows.

Unit III: Big Data and Cloud Foundations

Distributed storage, cloud computing, object storage, databases, containers, serverless orientation and scalable systems.

Unit IV: Applied Data Engineering Practice

Pipeline implementation, data cleaning, data lake/warehouse orientation, API-based data flows and deployment readiness.

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. Jules S. Damji et al., *Learning Spark*, O'Reilly Media.
4. Bill Lubanovic, *Introducing Python*, O'Reilly Media.
5. Thomas Erl, Zaigham Mahmood and Ricardo Puttini, *Cloud Computing: Concepts, Technology & Architecture*, Pearson.

GFT-MAI4204: Intelligent Systems — Sensing, Reasoning and Adaptation

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

Unit I: Intelligent Systems Foundations

Systems, environments, agents, sensing, perception, knowledge, reasoning, action and feedback.

Unit II: Sensing and Data Acquisition

Sensors, signals, measurements, IoT orientation, data streams, uncertainty and real-time system considerations.

Unit III: Reasoning, Learning and Adaptation

Rule-based reasoning, probabilistic reasoning, learning from data, adaptation, personalization and decision support.

Unit IV: Design of Intelligent Applications

Human-in-the-loop systems, cyber-physical systems, intelligent automation, evaluation, safety and responsible deployment.

Textbooks / References

1. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, Pearson.
2. Michael Negnevitsky, *Artificial Intelligence: A Guide to Intelligent Systems*, Pearson.
3. David L. Poole and Alan K. Mackworth, *Artificial Intelligence: Foundations of Computational Agents*, Cambridge University Press.
4. George F. Luger, *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*, Pearson.
5. Simon Haykin, *Neural Networks and Learning Machines*, Pearson.

GFT-MAI4205: Applied AI Lab I — Machine Learning and Intelligent Application Prototype

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

Unit I: Problem Selection and Data Preparation

Problem framing, dataset selection, data cleaning, feature engineering, exploratory analysis and baseline design.

Unit II: Model Building and Evaluation

Model selection, training, validation, metrics, error analysis, interpretation and performance reporting.

Unit III: Intelligent Application Prototype

Application workflow, model integration, user interface orientation, API/service design and prototype testing.

Unit IV: Documentation, Demonstration and Portfolio

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

Textbooks / References

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

GFT-MAO4201: Major Track Studio II — Applied Mathematics, Optimization and Model Reasoning

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

Unit I: Mathematical Reasoning for AI Models

Vectors, matrices, probability, statistics, gradients, loss functions and model behaviour interpretation.

Unit II: Optimization Foundations

Gradient descent, convexity intuition, regularization, numerical optimization and optimization diagnostics.

Unit III: Model Evaluation and Reasoning

Bias-variance, error analysis, calibration, robustness, explainability, uncertainty and model comparison.

Unit IV: Practice Portfolio

Mathematical model notebooks, optimization exercises, evaluation reports and model reasoning documentation.

Textbooks / References

1. Marc Peter Deisenroth, A. Aldo Faisal and Cheng Soon Ong, *Mathematics for Machine Learning*, Cambridge University Press.
2. Stephen Boyd and Lieven Vandenberghe, *Convex Optimization*, Cambridge University Press.
3. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer.
4. Kevin P. Murphy, *Machine Learning: A Probabilistic Perspective*, MIT Press.
5. Trevor Hastie, Robert Tibshirani and Jerome Friedman, *The Elements of Statistical Learning*, Springer.

Summer Term

Major Track Strengthening and Merger Readiness Block

GFT-MAO4S01: Major Track Studio III — Advanced AI Practice, NLP, Computer Vision and GenAI Foundations

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

Unit I: Advanced AI Practice Orientation

Model pipelines, feature engineering, classification, regression, clustering, evaluation and experiment tracking.

Unit II: Natural Language Processing Foundations

Text preprocessing, vectorization, embeddings, sequence models, transformers, sentiment analysis and text classification.

Unit III: Computer Vision Foundations

Image representation, filtering, feature extraction, CNNs, classification, detection and segmentation orientation.

Unit IV: Generative AI Foundations

LLMs, prompting, embeddings, retrieval-augmented generation, AI agents, evaluation, safety and responsible GenAI use.

Textbooks / References

1. Jurafsky and Martin, *Speech and Language Processing*, Pearson / Draft Online Edition.
2. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, *Introduction to Information Retrieval*, Cambridge University Press.
3. Richard Szeliski, *Computer Vision: Algorithms and Applications*, Springer.
4. Ian Goodfellow, Yoshua Bengio and Aaron Courville, *Deep Learning*, MIT Press.
5. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly Media.

GFT-MAO4S02: Major Track Studio IV — Research, Product Thinking and Minor Capstone Definition

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

Unit I: Research Reading and Problem Discovery

Research papers, literature review, gap identification, problem framing, research questions and evidence mapping.

Unit II: Product Thinking for AI Systems

User needs, stakeholder analysis, product requirements, value proposition, feasibility, risk and impact thinking.

Unit III: Capstone Concept Development

Problem statement, dataset plan, technical approach, evaluation plan, ethics, governance and project scope.

Unit IV: Minor Capstone Proposal and Portfolio

Proposal writing, presentation, review, iteration, concept note, prototype 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. Creswell and Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, SAGE.
3. Marty Cagan, *Inspired: How to Create Tech Products Customers Love*, Wiley.
4. Eric Ries, *The Lean Startup*, Crown Business.
5. Chip Huyen, *Designing Machine Learning Systems*, O'Reilly Media.

Semester III

Same as Integrated M.Sc. Semester IX

Specialization, Research and Advanced Intelligent Systems

GFT-AI5101: Specialization Elective I

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

Unit I: Specialization Foundations

Foundational concepts, terminology, landscape, applications and contemporary relevance of the chosen specialization pathway.

Unit II: Core Methods and Models

Important algorithms, models, frameworks, techniques and analytical methods relevant to the chosen specialization.

Unit III: Applied Systems and Case Studies

Domain applications, system architectures, real-world case studies, datasets, implementation issues and evaluation approaches.

Unit IV: Advanced Practice and Emerging Directions

Recent developments, limitations, responsible use, research opportunities and specialization portfolio tasks.

Textbooks / References

1. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, Pearson.
2. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer.
3. Ian Goodfellow, Yoshua Bengio and Aaron Courville, *Deep Learning*, MIT Press.
4. Jurafsky and Martin, *Speech and Language Processing*, Pearson / Draft Online Edition.
5. Richard Szeliski, *Computer Vision: Algorithms and Applications*, Springer.

GFT-AI5102: Specialization Elective II

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

Unit I: Advanced Specialization Concepts

Advanced principles, theoretical foundations, system context and deeper treatment of the selected specialization.

Unit II: Tools, Frameworks and Architectures

Software frameworks, system architectures, model pipelines, deployment patterns and experimentation workflows.

Unit III: Evaluation and Validation

Performance metrics, validation methods, benchmarking, robustness, explainability, risk and quality considerations.

Unit IV: Research and Industry Applications

Advanced case studies, recent papers, industry adoption, product possibilities 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. Chip Huyen, *Designing Machine Learning Systems*, O'Reilly Media.
4. Martin Kleppmann, *Designing Data-Intensive Applications*, O'Reilly Media.
5. Trevor Hastie, Robert Tibshirani and Jerome Friedman, *The Elements of Statistical Learning*, Springer.

GFT-AI5103: Advanced Research Methods for AI and Data Science

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

Unit I: Research Foundations in AI and Data Science

Research paradigms, literature review, problem formulation, research questions, hypotheses and research ethics.

Unit II: Experimental Design and Data-Driven Research

Datasets, sampling, experimental protocols, baselines, ablation studies, statistical validity and reproducibility.

Unit III: Research Communication and Scientific Writing

Paper structure, related work, methodology, results, discussion, citation practices, peer review and plagiarism avoidance.

Unit IV: Research Evaluation and Publication Readiness

Benchmarking, limitations, error analysis, responsible reporting, publication venues, research presentations and thesis preparation.

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. Robert K. Yin, *Case Study Research and Applications*, SAGE.
4. Peter J. Rousseeuw and Annick M. Leroy, *Robust Regression and Outlier Detection*, Wiley.
5. Judea Pearl, Madelyn Glymour and Nicholas P. Jewell, *Causal Inference in Statistics: A Primer*, Wiley.

GFT-AI5104: AI Systems Architecture and Scalable Intelligent Platforms

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

Unit I: AI System Architecture Foundations

AI system components, data layer, model layer, application layer, APIs, services, workflows and architecture patterns.

Unit II: Scalable Data and Model Platforms

Data pipelines, feature stores, model repositories, distributed processing, containers, cloud platforms and orchestration.

Unit III: Deployment, Monitoring and MLOps

Model serving, CI/CD, model monitoring, drift detection, observability, versioning, retraining and governance.

Unit IV: Intelligent Platform Design

Enterprise AI platforms, GenAI platforms, RAG systems, AI agents, security, reliability and responsible deployment.

Textbooks / References

1. Chip Huyen, *Designing Machine Learning Systems*, O'Reilly Media.
2. Martin Kleppmann, *Designing Data-Intensive Applications*, O'Reilly Media.
3. Emmanuel Ameisen, *Building Machine Learning Powered Applications*, O'Reilly Media.
4. Mark Treveil et al., *Introducing MLOps*, O'Reilly Media.
5. David Sculley et al., *Machine Learning: The High Interest Credit Card of Technical Debt*, Google Research Paper.

GFT-AI5105: Capstone Phase I — Research / Industry / Product Definition

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

Unit I: Capstone Problem Definition

Problem discovery, stakeholder analysis, domain context, research gap, product opportunity and capstone scope.

Unit II: Literature, Dataset and Feasibility Study

Literature review, dataset identification, data feasibility, technical feasibility, ethics and risk assessment.

Unit III: Solution Architecture and Evaluation Plan

System design, model plan, experiment plan, evaluation metrics, validation strategy and project milestones.

Unit IV: Capstone Proposal and Review

Proposal document, presentation, mentor review, iteration, project planning and portfolio evidence.

Textbooks / References

1. Wayne C. Booth, Gregory G. Colomb and Joseph M. Williams, *The Craft of Research*, University of Chicago Press.
2. Chip Huyen, *Designing Machine Learning Systems*, O'Reilly Media.
3. Marty Cagan, *Inspired: How to Create Tech Products Customers Love*, Wiley.
4. Cathy O'Neil and Rachel Schutt, *Doing Data Science*, O'Reilly Media.
5. Foster Provost and Tom Fawcett, *Data Science for Business*, O'Reilly Media.

GFT-MAO5101: Major Track Studio V — 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, technical stack selection and practice plan.

Unit II: Advanced Implementation Practice

Model implementation, data pipeline implementation, system component development and experimentation.

Unit III: Minor Capstone Phase I Development

Prototype design, implementation milestone, evaluation plan, review and iteration.

Unit IV: Practice Evidence and Technical Review

Code repository, notebook evidence, technical documentation, demo and mentor review.

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. Ian Goodfellow, Yoshua Bengio and Aaron Courville, *Deep Learning*, MIT Press.
4. Martin Kleppmann, *Designing Data-Intensive Applications*, O'Reilly Media.
5. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, Pearson.

Semester IV

Same as Integrated M.Sc. Semester X

Capstone, Professional Readiness and Future Leadership

GFT-AI5201: Specialization Elective III

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

Unit I: Specialization Consolidation

Advanced concepts, current challenges, track-specific theory, professional relevance and research directions.

Unit II: Advanced Applications and Systems

Complex applications, product systems, deployment models, real-world constraints and advanced case studies.

Unit III: Evaluation, Governance and Professional Use

Validation, safety, explainability, monitoring, governance, ethical implications and industry-readiness.

Unit IV: Specialization Portfolio and Future Directions

Portfolio artifact, review of recent work, innovation possibilities, research proposal and future learning roadmap.

Textbooks / References

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

GFT-AI5202: AI Governance, Policy, Safety and Future Technology Leadership

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

Unit I: Responsible AI Foundations

Fairness, bias, transparency, explainability, accountability, privacy, safety and human oversight.

Unit II: AI Risk, Safety and Model Governance

Risk management, robustness, misuse, auditability, model cards, data sheets, monitoring and governance lifecycle.

Unit III: AI Policy, Law and Institutional Governance

AI regulations, data protection, intellectual property, accountability, compliance, standards and organizational governance.

Unit IV: Future Technology Leadership

AI strategy, socio-technical impact, ethical leadership, future work, public systems, sustainability and human-centred innovation.

Textbooks / References

1. Virginia Dignum, *Responsible Artificial Intelligence*, Springer.
2. Luciano Floridi, *The Ethics of Artificial Intelligence*, Oxford University Press.
3. Cathy O'Neil, *Weapons of Math Destruction*, Crown.
4. Kate Crawford, *Atlas of AI*, Yale University Press.
5. Stuart Russell, *Human Compatible: Artificial Intelligence and the Problem of Control*, Viking.

GFT-AI5203: Capstone Phase II — Implementation, Evaluation and Dissertation

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

Unit I: Capstone Implementation

System development, model development, data pipeline, software integration and implementation documentation.

Unit II: Evaluation and Validation

Experimental evaluation, performance analysis, error analysis, user/stakeholder validation, limitations and risk review.

Unit III: Dissertation and Technical Documentation

Dissertation writing, methodology, results, discussion, references, appendices, reproducibility and professional documentation.

Unit IV: Final Demonstration and Viva

Final demo, portfolio publication, presentation, viva voce, reflection, deployment note and future extension plan.

Textbooks / References

1. Wayne C. Booth, Gregory G. Colomb and Joseph M. Williams, *The Craft of Research*, University of Chicago Press.
2. Chip Huyen, *Designing Machine Learning Systems*, O'Reilly Media.
3. Emmanuel Ameisen, *Building Machine Learning Powered Applications*, O'Reilly Media.
4. Creswell and Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, SAGE.
5. Marty Cagan, *Inspired: How to Create Tech Products Customers Love*, Wiley.

GFT-MAO5201: Major Track Studio VI — Professional Portfolio, Minor Capstone Phase II and Deployment Readiness

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

Unit I: Minor Capstone Completion

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

Unit II: Deployment and Product Readiness

Deployment workflow, demo environment, documentation, model card, product note and usage guide.

Unit III: Professional Portfolio Development

Portfolio design, Git repository, technical resume, project page, presentation deck and professional narrative.

Unit IV: Review, Viva and Career Readiness

Portfolio review, technical viva, mock presentation, publication/product 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. Foster Provost and Tom Fawcett, *Data Science for Business*, O'Reilly Media.