

E-Track Data Science & AI Liberal Arts and Major Courses: Targets and Learning Outcomes (TLO)

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					What is the purpose of the course and what will students learn/understand from the course?	What are the course objectives and learning outcomes students are expected to achieve?	DP1	DP2	DP3	DP4	DP5	DP6
							The ability to acquire wide-range of knowledge and diverse perspectives in a wide variety of fields to address business, technology and societal issues.	The ability to acquire the academic and technical knowledge on data science, AI and digital business, and the ability to productively use such knowledge.	The ability to collect and logically analyze diverse information and big data to resolve real-world problems.	The ability to grasp diverse values and cultures of the global society and to tackle challenging problems independently as well as in cooperation with others.	The ability to engage in society as a global citizen and contribute to sustainability.	The ability to innovate and advance the business and society with a sense of humanity and an ethical mind.
Big Data Management	100	Lecture	4	●	This course examines database design and SQL programming, the foundations of database systems, and core concepts such as the relational algebra and data model, query optimization, query processing, and transactions. Students learn how to design and implement data strategies, on-premise and cloud systems, and centralized and distributed architectures. With this knowledge, students are empowered to make informed decisions about which technologies to use in certain situations for specific goals.	Students should become able to design the optimal database system depending on the requirements using SQL programming.	○	◎	◎			
Introduction to Data Analytics	100	Lecture	2	●	This course introduces statistical thinking for analyzing and interpreting data in real-world contexts. Students learn core concepts such as exploratory data analysis, probability, hypothesis testing, and regression. Using the R programming language, the course emphasizes hands-on analysis of data science problems. It builds a strong foundation for evidence-based decision-making using data.	Students should gain the basic understanding of statistical and data analysis, and become able to use the R programming language.	◎	○	◎			○
Introduction to Data Science and Programming	100	Lecture	2	●	This course introduces the foundations of data science and shows how data can be transformed into meaningful insights through computation and programming. Using Python, the course builds confidence in problem-solving and data-driven thinking. It is an ideal starting point for students interested in understanding how data powers modern decision-making and technology.	Students should become able to explore, visualize, and analyze relevant data while gaining hands-on experience writing practical programs using Python programming language.	◎	○	◎		○	
Mathematics for Data Science I	100	Lecture	4	●	This course teaches essential calculus concepts for data science, as well as their mathematical notation, physical meaning, and geometric interpretation. Students will gain insight into real-world applications of these mathematical concepts, as well as an understanding of the differentiation and integration of single variable and coordinated systems, to develop fundamental computation skills for problem solving.	Students should become able to understand and apply the basic calculus concepts such as single-variable differentiation and calculus to physical and data science problems.	○	◎	◎			
Mathematics for Data Science II	100	Lecture	4	●	This course expands mathematical foundations with vectors and matrices, partial derivatives, double and triple integrals, vector calculus, and discrete mathematics. Fundamental concepts are also taught, including definitions, proofs, sets, functions, graphs and networks. Students will be able to explain and apply discrete methods in subsequent courses in the design and analysis of algorithms, software engineering, and computer systems.	Students should become able to understand and apply the mathematical concepts such as multiple-variable calculus, vector and matrix to practical problems. Students should also become able to understand the basic concepts of discrete mathematics used in data analysis.	○	◎	◎			

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Python for Data Science	100	Lecture	4	●	This course examines techniques for using Python in data science as well as the different frameworks in Python for solving real-world problems. This course also discusses using AI-assisted coding tools responsibly while maintaining correctness and reproducibility.	Students should become able to use standard Python tools to write code for data collection, preprocessing, analysis and visualization as well as AI-assisted coding tools.	○	◎	◎			
Statistics for Data Science	100	Lecture	4	●	This course introduces probabilistic reasoning and statistical models used in data science. Topics include conditional probability, distribution of random variables and order statistics, sampling and sampling distributions, law of large numbers, and central limit theorem. Students also learn statistical models including linear, binary, and multinomial logistic regression models, using the R computing language as applicable.	Students should become able to understand the basic statistical concepts and properly apply them to practical data science problems involving uncertainties.	◎	○	◎	○		
Computation Structures	200	Lecture	4	●	This course introduces the architecture of digital systems, emphasizing structural principles common to a wide range of technologies. This course covers topics including multilevel implementation strategies, the definitions of new primitives and their mechanization using lower-level elements, and other topics, providing a deep understanding of how computation works beneath the surface.	Students should become able to understand the basic architectural principles of computation, which could be applied to a wide range of technologies. Students should become confident in learning the emerging computation technologies.		◎	◎	○		
Computer System Design	200	Lecture	4	●	This course covers topics on the engineering of computer software and hardware systems. Topics include techniques for controlling complexity, modularity using client-server design, operating systems, networks, security and privacy.	Students should become able to understand the basics of computer system design such as client-server design, operating systems, networks and security, and to study further more advanced technologies.		◎	◎	○		
Discrete Optimization	200	Lecture	4	●	This is an intermediate algorithms course that examines the design and analysis of efficient algorithms, with an emphasis on methods of application. Topics include divide-and-conquer, randomization, dynamic programming, greedy algorithms, incremental improvement, complexity, and cryptography.	Students should be able to develop the mathematical models and the algorithms to optimally solve the data science problems.		◎	◎	○		
Microeconomics	200	Lecture	4	●	To understand how to apply the theoretical tools to understand microeconomic phenomena.	To be able to apply the fundamental concepts of microeconomics, such as consumer theory, producer theory, supply and demand, market structures, and welfare economics, to understand economic issues.	○	◎	○	◎		
Practical Programming in C	200	Lecture	2	●	This course introduces the C programming language, a foundation of modern operating systems and embedded systems. Students learn core syntax and practical programming techniques, progressing to advanced topics such as memory management, concurrency, and synchronization. The course prepares students for careers in systems and embedded software development.	Students should be able to write the C programming language codes for practical problems.		◎	◎	○		

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Principles of Algorithms	200	Lecture	4	●	This course provides an introduction to mathematical modeling of computational problems. It covers the common algorithms, algorithmic paradigms, and data structures used to solve these problems. The course emphasizes the relationship between algorithms and programming, and introduces basic performance measures and analysis techniques for these problems.	Students should become able to understand the basics of data structure and algorithm to run the computers efficiently in a software sense. Students should establish a basics to write an efficient software code with a good understanding of algorithms and programming.		◎	◎	○		
Principles of Deep Learning	200	Lecture	4	●	This course explores neural networks and modern deep learning architectures inspired by the human brain. Students learn models such as Convolutional and Recurrent Neural Networks used in computer vision and speech recognition. The course emphasizes practical problem-solving with deep learning techniques. Students gain insight into how deep learning enables powerful AI systems.	Students should become able to develop deep learning models such as Convolutional and Recurrent Neural Networks used in computer vision and speech recognition as well as data analytics.		◎	◎	○		○
Principles of Machine Learning	200	Lecture	4	●	This course introduces principles, algorithms, and applications of machine learning from the point of view of modeling and prediction. It includes the formulation of learning problems and concepts of representation, over-fitting, and generalization. These concepts are exercised in supervised learning and reinforcement learning, with a variety of practical applications.	Students should become able to develop machine learning models to solve practical physical and data science problems.		◎	◎	○		○
Principles of Marketing	200	Lecture	4	●	To understand the basic principles of marketing, including: segmentation, targeting, positioning, and the marketing mix (product, price, place, and promotion).	To be able to analyze real-world marketing examples by using knowledge of analytical methods and tools for marketing.	○	◎	○	◎		
Software Construction	200	Lecture	4	●	This course examines fundamental principles and techniques of software development. Topics covered in this course include specifications and invariants, testing, abstract data types, design patterns for object-oriented programming, concurrent programming and concurrency, and functional programming.	Students should become able to write software that is safe, adaptable and easy to understand, applying the fundamental principles and techniques of software development.		◎	◎	○		
Statistical Analysis	200	Lecture	4	●	This course explores the theoretical foundations of statistical inference and modeling. Students study topics including sufficiency and completeness, point estimation via maximum likelihood and Bayes, estimator optimality via UMVUE, hypothesis testing and confidence regions, and Markov chain Monte Carlo for Bayesian inference. Emphasis is placed on rigorous reasoning and research-level analysis. Extensive use of R prepares students for advanced data science research and applications.	Students should become able to understand the rigorous theory of statistics and apply the various statistical tools to address the data science problems in a professional level.		◎	◎	○		○
AI Engineering	300	Lecture	4	●	This course focuses on building, deploying, and managing AI-powered applications. Students learn to connect Large Language Models or Machine Learning Models to software via Application Programming Interfaces, and to turn various models into scalable and reliable products.	The students should become able to integrate the various AI tools and platforms using Application Programming Interfaces to develop a complete AI solution to practical data science problems.		◎	◎		○	○
AI & Intelligent Product Development	300	Lecture	4	●	To understand the AI product development through engaging AI case studies and studying building blocks of AI systems.	To be able to conceptualize and develop AI products by thinking in an AI way and understanding and creating opportunities to use NLP, ML, IoT along with Neural, Exploratory, and Evolutionary machine learning paradigms.		◎	○		○	◎
Blockchain & Business Applications	300	Lecture	4	●	To understand the basics and applications of Blockchain technology, including its protocols, anonymity, and security issue, with its underlying legal, political and social aspects.	To be able to learn the details of Blockchain technology and its existing applications such as Bitcoin, Ethereum, etc. and to develop its applications.		◎	◎		○	○

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Business Analytics and AI Project	300	Lecture	4	●	To understand how to apply the business analytics lifecycle to real-world business problems, including data preprocessing, exploratory data analysis, feature engineering, and the development of statistical, machine-learning, and/or deep learning models.	To be able to demonstrate independent thinking in business analytics projects by generating new ideas, defining appropriate key performance indicators (KPIs), following the data science workflow, and executing analytics projects while considering cost-effectiveness, KPI-based performance, and model explainability.		◎	◎	○		○
Corporate Finance	300	Lecture	4	●	To understand the modern finance theory and its application to real-world financial management issues.	To be able to understand finance and accounting fundamentals, analyze financial statements, exercise capital budgeting techniques, and analyze capital structure and dividends policy.		◎	◎	○	○	
Cybersecurity and Applications	300	Lecture	4	●	To understand the concepts of cybersecurity and information security, the data on them, and the applications they provide.	To be able to understand cybersecurity and information security concepts in business contexts as well as cryptography tools. To be able to develop skills in the processes associated with information security and privacy.		◎	○	○	○	
Data Science and AI Project I	400	Lecture	4	●	This first capstone course allows students to apply their knowledge to a real-world data science or AI project. Working in teams, students define a problem, acquire and preprocess data, and begin designing an AI solution. The course emphasizes project planning, collaboration, and iterative development. It lays the foundation for a complete end-to-end AI system.	To be able to demonstrate independent thinking in business analytics projects by generating new ideas, defining appropriate key performance indicators (KPIs), following the data science workflow, and executing analytics projects while considering cost-effectiveness, KPI-based performance, and model explainability.		◎	◎	○	○	○
Data Science and AI Project II	400	Lecture	4	●	Building on Project I, this course focuses on refining and completing the capstone project. Students improve models, strengthen system design, and conduct rigorous evaluation. The course emphasizes professional documentation and presentation of results. Students complete the course with a polished project suitable for portfolios and industry use.	The students should become able to work in a group to refine the first-cut solutions developed in a data science and AI project. The students should be able to effectively document and communicate the results.		◎	◎	○	○	○
Digital Banking and Fintech	300	Lecture	4	●	To understand elements of digital banking, such as mobile and internet banking, branchless banking, POS, etc. and also AI, Deep Learning and Blockchain technologies in FinTech.	To be able to improve tools, approaches and platforms of Digital Banking, by understanding technological, social and legal backgrounds of Digital Banking and FinTech. To be able to understand how FinTech emerges through technological advances. To be able to understand blockchains, Bitcoin and Ethereum in Fintech as well as the role of AI and Deep Learning in FinTech.		◎	○	○		○
Digital Marketing	300	Lecture	4	●	To understand diverse tools for digital marketing, such as website structure, HTML tags, Search Engine Optimization, marketing metrics for performance measurement, etc.	To be able to provide sound suggestions and strategies to achieve marketing objectives by developing metrics for evaluating digital marketing campaigns.		◎	◎	○		○
Econometrics for Business Analytics	300	Lecture	4	●	To understand the basic concepts and methods used in econometrics (e.g. OLS, IV, unit root, etc.) applied to different data structure (e.g. time series and cross section). Furthermore, understand, identify, and deal with the most common problems generate by the methods and data used in our analysis. We will see some applications and perform some examples.	To be able to use data with different structure, identify the pros and cos of some specific datasets. We will be able to analyze and apply some econometric methods and perform the corresponding economic inference.		◎	◎	○		○
Financial Accounting	300	Lecture	4	●	To understand the accounting fundamentals governing the preparation of financial statements, also covering such topics as cash flow and financial statement analysis.	To be able to analyze transactions and financial statements, know the accounting cycle, and actually prepare financial statements.		◎	◎	○		

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Generative AI	300	Lecture	4	●	This course introduces the core concepts and practical applications of Generative AI and large language models. Students learn prompt engineering, output evaluation, and application design using existing AI tools and platforms. The course emphasizes responsible use, addressing ethical, social, bias, and reliability concerns. It prepares students to apply generative AI effectively in digital and business contexts.	The students should become able to understand the basics of Generative AI and use various Generative AI tools and platforms. The students should become able to use it in an ethical and responsible way.		◎	◎	○	○	○
Natural Language Processing	300	Lecture	4	●	The course is to study algorithms for understanding, interpreting and generating human language. You will learn theory and practice leading to design and development of a wide spectrum of applications like sentiment analysis, machine translation, text classification, question answering, text summarization, and building chatbots utilizing human language processing, affective computing and cognitive computing.	The students should become able to handle any text data in the development of AI systems.		◎	◎	○		
Text Mining & Deep Learning	300	Lecture	4	●	To understand different types of natural language processing (NLP), its methods of disambiguation, co-reference resolution, etc., and its relations to text mining and algorithms.	To be able to learn different Natural Language Processing methods and text data mining applications, and conduct simple NLP and text mining tasks.		◎	◎	○	○	
Undergraduate Thesis Writing Seminar	300	Seminar	4	●	To provide students with important guidelines and skills for how to develop a topic, how to find and organize sources, and how to organize and present a thesis proposal.	To be able to develop topics into a viable research proposal for a thesis by clarifying a basic question, developing the basic framework, identifying methodology/data used.		◎		○	○	◎
Digital Marketing and E-Commerce	300	Lecture	4	●	To understand the key principles of digital marketing and e-commerce; students will learn how to develop and implement effective marketing strategies using the SOSTAC framework.	To be able to develop and implement effective digital marketing strategies that align with business goals using the SOSTAC framework, and gain expertise in key areas such as SEO, social media marketing, content marketing, email marketing and online advertising.		○	◎	◎		○
Innovation and Value Creation for Entrepreneurs	300	Lecture	4	●	To understand the tools and methodologies necessary to foster innovation and create value in entrepreneurial ventures. Students will learn to integrate innovation strategies, enhance decision-making, and solve complex problems using the Value Creation Wheel (VCW). They will understand how to apply these concepts across the phases of value creation, including discovery, ideation, assessment, implementation, and consolidation.	To be able to apply the Value Creation Wheel (VCW) framework across five phases of innovation, leveraging Human Intelligence and collaborative tools. They will develop measurable strategies, create innovative solutions, engage key decision-makers, and communicate effectively through pitches and presentations, fostering critical thinking and ethical decision-making in entrepreneurial value creation.			○	◎	○	◎
Neuro Marketing	300	Lecture	4	●	To understand Neuromarketing foundations; The course bridges the disciplines of neuroscience, psychology, and marketing to explore how human brain activity and behavior can inform marketing strategies.	To be able to critically analyze the benefits, challenges, and ethical considerations of applying neuroscience to understand consumer decision-making and evaluate consumer behavior.		◎	◎	○		○
Investments	400	Lecture	4	●	To understand the fundamentals of investment analysis and management, covering (1) various financial assets and their pricing models, (2) bond, equity, and derivatives, and (3) portfolio and investment.	To be able to value common financial assets, engage in fundamental analysis and modeling, and formulate portfolio and investment strategies.		◎	○	○	○	
IT Project Management	400	Lecture	4	●	To understand the basic and advanced concepts of contemporary project management, covering strategic and risk management, budget, monitoring, termination, and reporting.	To be able to prepare project proposal bids and documents, construct the organizational structure, and manage the project through diverse management practices.		◎	◎	○	○	
Neuro Marketing Project	400	Lecture	4	●	To understand a project-based exploration of neuromarketing, combining advanced theoretical knowledge with practical application. Students will work collaboratively to design and implement neuromarketing research projects, applying cutting-edge tools and methodologies to solve real-world marketing challenges.	To be able to equip students with advanced neuromarketing knowledge, hands-on experience with tools like eye-tracking, and the ability to design and execute research projects. To be able to critically assess ethical issues, analyze consumer behavior, and apply neuroscience insights to develop strategic marketing solutions for real-world challenges.			◎	◎	○	○

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Quantum Information and Computation	400	Lecture	4	●	To understand the basic concepts, algorithms, circuits and realization platforms of quantum computers and various quantum technologies.	To be able to understand all the basic concepts of quantum computation and quantum technologies. To be able to design quantum algorithms and quantum circuits. To be able to create and quantify entanglement, identify and model quantum decoherence, design and implement quantum error correction schemes, design and implement multipartite entangled quantum networks, understand physical quantum computers in various platforms, and use IBM's quantum computer.		◎	◎			○
Start-up Funding and VC Strategies	400	Lecture	4	●	To understand funding options and their key evaluation base for startups, covering crowdfunding, angel investments, incubators and accelerators and venture capital.	To be able to produce a competent start-up plan, identify the advantages and disadvantages of different funding options. To be able to identify the elements of a good pitch and replicate it and design a plan to obtain funding.		◎	○	○		◎
Strategic Brand Management	400	Lecture	4	●	To understand the strategic importance of building a strong brand and consumer-based brand equity in driving competitive advantage and fostering brand resonance.	To be able to understand the strategic role of brand development and management in driving competitive advantage, and to analyze and apply key principles of brand equity, brand performance, and strategic brand management.		◎	○	○		○
Undergraduate Thesis	400	Independent Study	4	●	To explore the topic of the student's interest. To develop causal arguments and test them with empirical evidence.	To be able to produce a major research paper based on scientific methods.		◎		○	○	◎
Topics in Data Science and AI	300/400	Lecture	2		Topics vary, depending on instructors. Classes meet once a week.	To be able to acquire knowledge and experience of the topic.		◎	○	○		○
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