Course Catalog 2023/24

Title of Program : Bachelor's Degree in Mathematics, Specialization in Data Science for Artificial Intelligence

Program Code	6-L-MATH
Level	Undergraduate
Credits and Duration	**198 ECTS credits taken over 6semesters**
Delivery Language	English

Academic Calendar

July 2023

Mo	Tu	We	Th	Fr	Sa	Su
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
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31						

August 2023

Mo	Tu	We	Th	Fr	Sa	Su
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September 2023

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October 2023

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November 2023

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December 2023

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1	1	1	1	2	2	2
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1	1	2	2	2	2	2
8	9	0	1	2	3	4
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January 2024

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February 2024

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March 2024

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April 2024

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May 2024

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June 2024

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Program Overview

The goals of the Bachelor in Mathematics, Specialization in Data Science for Artificial Intelligence are to:

- Provide students with an in-depth exposure to diverse areas of mathematics, such as Analysis, Algebra, Discrete Mathematics, Probability and Statistics.
- Provide students with an in-depth exposure to the theoretical foundations and the operational techniques of Data Science and Machine Learning, as well as to the main modeling tools/digital information environments which are typically used in those fields.
- Develop strong critical thinking skills, which coupled with the technical competencies acquired in the Bachelor, guarantees advanced analysis, modelling and problem-solving capabilities needed in Business and industrial setups.
- Provide students with the necessary background to further pursue their studies in Mathematics and/or Data Science and Machine Learning, should they wish to do so.

Learning Outcomes

PLO 1	**Demonstrate knowledge and understanding of diverse areas in mathematics, such as Analysis, Algebra, Discrete Mathematics, Probability and Statistics.**
PLO 2	**Demonstrate knowledge and understanding of the fundamentals of Data Science and Machine Learning as well as appreciate the societal/philosophical impact of the technologies stemming thereof.**
PLO 3	**Develop a tangible set of skills to mine information from high-dimensional data sets and use them in prediction, both in academic and in industrial setups.**
PLO 4	**Demonstrate a consolidated technical grounding in mathematical, statistical and computational techniques and use them in a problem-solving perspective to address both theoretical and practical applications.**

PLO 5	**Acquire proficiency in extracting/interpreting mathematical, statistical and computational information and in communicating such content clearly and coherently**
PLO 6	**Use previously acquired mathematical, statistical and computational knowledge to explore new, more advanced such content, be it either for addressing novel complex applications or to engage in basic research activities**

Program Structure / Structure de la Formation

Licence 1 Semester 1			
UE	Course Name	Credits	Date
LU1MA001	Mathematics 1	9	Sep- Dec 2023
LU1MEPY1	Mechanics-Physics 1	6	Sep- Dec 2023
LU1SXOIP	Integration into the World of Work 1	3	Sep- Dec 2023
LU1MAAD1	Philosophy and Ethics of Artificial Intelligence	6	Sep- Dec 2023
LU1IN001	Computer Science	6	Sep- Dec 2023
	UAE Studies	0	Sep- Dec 2023
LU1LVAD1	Languages	3	Sep- Dec 2023

Licence 1 Semester 2			
UE	Course Name	Credits	Date
LU1MA002	Mathematics 2	6	January – May 2024
LU1MA003	Complements in Analysis and Linear Algebra	9	January – May 2024
LU1MAAD2	Introduction to Mathematical Logic	3	January – May 2024
LU1MAAD3 LU1SXAR2	Descriptive Statistics and Introduction to R Active Science – Project in Descriptive Statistics	12	January – May 2024
	UAE Studies	0	January – May 2024
LU1LVAD2	Languages	3	January – May 2024

Licence 2 Semester 3			
UE	Course Name	Credits	Date
LU2MA260	Sequences and	6	Sep- Dec 2023

	Series of Functions		
LU2MA216	Topology and Analysis 1	6	Sep- Dec 2023
LU2MA221	Linear and Bilinear Algebra 1	6	Sep- Dec 2023
LU2MA440	Discrete Probability, Combinatorics and Graphs	12	Sep- Dec 2023
	Languages	3	Sep- Dec 2023

Licence 2 Semester 4			
UE	Course Name	Credits	Date
LU2MA241	Introduction to Probability models	6	January – May 2024
LU2MA312	Lebesgue integrals and complements in Probability Theory	9	January – May 2024
LU2MA122	Linear and Bilinear Algebra 2	6	January – May 2024
LU2MA392	Multidimensional Data Analysis	9	January – May 2024
LU1LVAD2	Languages	3	January – May 2024

Licence 3 Semester 5			
UE	Course Name	Credits	Date
LU3MA264	Measure and Integration theory	6	Sep- Dec 2023
LU3MA260	Topology and analysis 2	6	Sep- Dec 2023
LU3MA490	Statistical inference	12	Sep- Dec 2023
LU3MA276	Numerical analysis and optimization	6	Sep- Dec 2023
LU3FLE01	Languages	3	Sep- Dec 2023

Licence 3 Semester 6			
UE	Course Name	Credits	Date
LU3MA391	Advanced Probability Theory	9	January – May 2024
LU3MA310	Functional Analysis	9	January – May 2024
LU3MA180	Data Science and Machine Learning	9	January – May 2024
LU3MAOI1	Integration to the World of Work 2	3	January – May 2024
LU2FLE02	Languages	3	January – May 2024

Course Details – L1

Course Title & Code	**Mathematics for Sciences 1 – MATH 100**
Instructor	Dr Omar El Dakkak- Dr Grace Younes
Date	September- December 2023
Course Format	weekly class
Credits	9
Level	Undergraduate
Semester offered	1
Contact Hours	90 Total Time Commitment: 90
Course Description	This course constitutes a thorough and rigorous introduction to univariate and multivariate differential calculus. Students are first introduced to Euclidean spaces and their main algebraic and topological properties. After this introduction, a rigorous treatment of the limit operation is presented, both for real functions of one variable and of several variables. Follows a thorough treatment of continuity and differentiability, once more for real functions of one and of more than one variable. Elements of optimization are then introduced. The course ends with an introduction to primitivizing and to the basic theory of differential equations. More specifically, separable variables differential equations, first-order linear differential equations as well as second-order differential equations with constant coefficients will be analysed in detail.
Evaluation	100%CC

Course Title & Code	**Mechanics-Physics 1 - PHYS 125**
Instructor	Dr Eliane Bsaibess
Date	September December 2023
Course Format	weekly class
Credits	6
Level	Undergraduate
Semester offered	1
Contact Hours	64 Total Time Commitment: 64

Course Description	This course covers the concepts and theories related to mechanical and thermodynamic equilibrium of macroscopic systems at rest or under a uniform linear motion. The course will include the study of four main topics. 1. *Dimensions in mechanics and physics*, covering the concepts of physical quantities, dimensions, and units. 2. *Equilibrium of mechanical systems*, introducing the concepts and methods to study the equilibrium of a mechanical system, including Newton's laws, the notion of forces, and the rotational and translational equilibrium. 3. *Hydrostatics*, presenting the equations utilized for studying the equilibrium in fluids (gases or liquids) and immersed solids. 4. *Thermodynamics,* introducing the quantities used to describe the state of a thermodynamic system, introducing the concepts of temperature and heat.
Evaluation	100%CC

Course Title & Code	**Integration to the world of work 1 - PHYS 105**
Instructor	Part Time Maria El Hassrouni – Part Time Anita Roberts
Date	September- December 2023
Course Format	weekly class
Credits	3
Level	Undergraduate
Semester offered	1
Contact Hours	30 Total Time Commitment: 30
Course Description	In this course, students will explore their own self, career aspirations, and the world around them. They will be armed to harmoniously face a professional world that is in continuous evolution. They will reflect on their career. The course explores two aspects. The first aspect focuses on the individual, through self-assessment and learning skills such as writing a CV and presenting oneself. The second aspect focuses on global trends and their current and future impact on the individual, society and economy. More precisely, students learn how the world of work is changing. As a result, they are made aware of the nature of competencies that will be relevant in the future and how their newly acquired skillsets can be employed to foster a successful career. The specific case of mathematicians and physicists will be tackled along the course.
Evaluation	100%CC

Course Title & Code	**Philosophy and Ethics of Artificial Intelligence – MATH -113**
Instructor	Dr Claude Vishnu Spaak
Date	September- December 2023
Course Format	weekly class
Credits	6
Level	Undergraduate
Semester offered	1
Contact Hours	60 Total Time Commitment: 60
Course Description	With the growing impact of the digital transformation in the last decades, our epoch now stands in front of a 4th Industrial Revolution, described by the World Economic Forum as a "fusion of technologies that is blurring the lines between the physical, digital, and biological spheres" (Schwab, 2016). The development of Artificial intelligence (AI) lies at the center of this undergoing process. This introductory course to the philosophy of artificial intelligence offers a look at the main ethical, metaphysical and social problems related to the development of AI. From the ethical perspective, AI can be seen as a formidable technological tool to ameliorate our lives by improving the efficiency of operations and processes which until today relied exclusively on the fallible powers of humans, in such domains as medicine, transportation, education, environmental sustainability, etc. However the risk of infallibility cannot escape AI, if only because it is programmed by humans. Even if one grants that AI is more reliable than human intelligence, how to hold an automated system morally accountable and responsible if it happens to misjudge a situation and makes a mistake? Given that ethics itself is a field of enquiry that contains various competing ethical theories (which can conflict in ethical dilemma), what set of ethical norms should artificially intelligent devices be programmed with? Won't such norms inevitably enter in conflict with other sets of competing norms? From the social and legal perspective AI is about to affect more and more the labor market with robots and machine-learning systems starting to replace human workers: will this have an impact on unemployment or can one expect a reshaping of the structure of labor with new types of jobs and labor structures to emerge from this technological revolution? This also brings a question of social justice: what are the necessary conditions for a socially fair redistribution of the economic value produced through AI? Lastly, AI poses core metaphysical problems: what is the nature of the intelligence at work in AI? Is it merely a calculative and instrumental set of processes that mimic human intelligence, but which in the end are merely in the continuation of how a simple calculator operates? Is

	AI blind to what it does, and in this sense must we agree that there is no intelligence attached to it in the strong sense in which one says that the human being is intelligent? Perhaps on the contrary AI urges us to rethink in a new way the very meaning of intelligence: are attributes of intelligence that we classically ascribe to the human spirit (consciousness, awareness, intuition, understanding, reason, etc.) something else than biological / evolution based aptitudes by which the human species confronts a series of adaptive problems, in a way that is not substantially different from what a programmed artificially intelligent device does at its own level of complexity?
Evaluation	100%CC

Course Title & Code	**Computer Science - CPSC 100**
Instructor	Dr Eliane Bsaibess -Dr Lama Tarsissi
Date	September- December 2023
Course Format	weekly class
Credits	6
Level	Undergraduate
Semester offered	1
Contact Hours	60 Total Time Commitment: 60
Course Description	The Computer science course is divided into two parts. Part 1: Introduction to the programming language Python (multi-platform language). Master the skills to navigate online notebooks and work with the Spyder interface using Anaconda navigator. Explore and grasp the basic notions of data structure like lists and arrays. Familiarize with practical modulus and their built-in functions. Develop logical reasoning abilities through for and while loops, and apply constructive algorithms to solve problems in mathematics, statistics, and image processing. Part 2: Introduction to the typesetting scientific text editor LaTex. Explore and grasp the basic notions of representing a good report

	Acquire the skills to represent a presentation using Beamer. The course concludes with a comprehensive understanding of both Python and LaTex in relation to scientific text editing.
Evaluation	100%CC

Course Title & Code	**UAE Studies – GEED 101**
Instructor	Dr Kosmas Pavlopoulos - Dr Kévin Taillandier
Date	September- December 2023
Course Format	weekly class
Credits	0
Level	Undergraduate
Semester offered	1
Contact Hours	30 Total Time Commitment: 30
Course Description	• Physical Geography courses aim to understand how the Earth's physical environment of the UAE underlies and is affected by human activity over time. A holistic analysis of Earth systems and environmental change is attempted. This involves a representation of all environments in the UAE, including terrestrial, coastal, and marine, with case studies of the UAE's natural environment. The course will explore issues and challenges related to water resources and the energy transition in the context of sustainable development. • Human Geography courses examine a range of topics related to economic, urban, social, and cultural geography. Students will mobilize key geographical skills and materials to describe and critically analyze the impacts of globalization on the UAE. Through oral presentations and face-to-face interviews, they will strengthen both their communication skills and their knowledge of where they live. History courses intend to explore the rich history of the UAE, beginning with the early history of the aera and the people, the cultural developments, and the drastic transformations of the territory between the 16th century and the 21st century
Evaluation	50% CC-50% CF

Course Title & Code	**Mathematics for Sciences 2 – MATH 114**
Instructor	Dr Grace Younes
Date	January – May 2024
Course Format	weekly class
Credits	6
Level	Undergraduate

Semester offered	2
Contact Hours	60 Total Time Commitment: 60
Course Description	This course provides an introduction to students in Sciences to Linear Algebra on Euclidean spaces. The course covers typical topics that are presented at such a level: systems of linear equations, matrices, matrix algebra, determinants and inverses, linear combinations, linear independence, and R^n subspaces. A number somewhat more advanced topics are also seen in the course, namely linear transformations, isomorphisms, matrix representation of linear maps, eigenvalues and eigenvectors, diagonalization, similarity and inner product spaces.
Evaluation	100%CC

Course Title & Code	**Complements in Analysis and Linear Algebra -MATH 160**
Instructor	Dr Sudarshan Shinde – Dr Gianluca Mola
Date	January – May 2024
Course Format	weekly class
Credits	9
Level	Undergraduate
Semester offered	2
Contact Hours	90 Total Time Commitment: 90
Course Description	The purpose of this course, which, unlike MATH 100 and MATH 200 is program-specific, is to provide a deeper, more rigorous treatment of some of the topics seen in MATH 100 and MATH 200, as is suitable for mathematicians. The course is divided in two parts: the first part provides complements in Analysis and the second parts provides complements in Linear Algebra. More precisely, the Analysis part starts with a thorough study of convergence of complex and real-valued sequences and the Bolzano-Weierstrass Theorem, it follows on with a theoretically complete study of limits, continuity and derivability of real functions of a real variable, and of sequences defined through a recursion. It ends with a rigorous presentation of Riemann integrals. The Linear Algebra part (which telescopes the Linear Algebra part of MATH 200), starts with a complete, rigorous presentation of the theory of vector spaces, exhibiting how not only Euclidean spaces enjoy this structure but also suitable spaces of sequences and general functions do enjoy it. In this framework, the theory of linear maps is developed and, once more, it is shown that rather abstract operators (such as differentiation) can be considered as linear maps. The course ends with a rigorous presentation of the theory of diagonalization of linear maps.
Evaluation	100%CC

Course Title & Code	**Introduction to Mathematical Logic - MATH 130 –**
Instructor	Dr Grace Younes
Date	January – May 2024
Course Format	weekly class
Credits	3
Level	Undergraduate
Semester offered	2
Contact Hours	30 Total Time Commitment: 30
Course Description	This course provides first an introduction to the basic concepts and results of mathematical logic and set theory through basic logical structures and the concepts of classes and sets, functions, relations, and partially ordered classes. In the second part of the course, students are introduced to abstract algebra. In particular, basic mathematical structures such as groups and rings are introduced and studied.
Evaluation	100%CC

Course Title & Code	**Descriptive Statistics and Introduction to R- MATH 170**
Instructor	Dr Omar El Dakkak – Dr Samuel Feng
Date	January – May 2024
Course Format	weekly class
Credits	9
Level	Undergraduate
Semester offered	2
Contact Hours	90 Total Time Commitment: 90
Course Description	The course is a first hands-on introduction to Data Science. Students are introduced and made familiar with different types of statistical variables (quantitative, qualitative, categorical, etc.), wherefrom different types of centrality indices such as means, modes, medians as well as dispersion indices such as standard deviations and variances, obviously whenever they make sense. Next, various instruments of visualization are introduced (different types of charts, histograms, etc.). The univariate data analysis ends with a complete presentation of the analysis of concentration and the definition of the Gini index. The course moves then to the bivariate descriptive statistics topics. In this case, the analysis of Association and Dependence are presented (for both quantitative and qualitative data). The course ends with some notions of time-series Analysis. In general, after each lecture, students follow a computer lab. The aim of these practical sessions is twofold: on the one hand to teach and train students on one of the most widely used statistics packages: R, and on the other hand, to use such a

	platform to conduct analyses on given data sets, applying the notions seen during the lectures.
Evaluation	100%CC

Course Title & Code	**Active Science: Project in Descriptive Statistics - MATH 175**
Instructor	Dr Maxence De Rochechouart
Date	January – May 2024
Course Format	weekly class
Credits	3
Level	Undergraduate
Semester offered	2
Contact Hours	30 Total Time Commitment: 30
Course Description	This course, whose assessment is exclusively project-based, is strictly linked to MATH 170 - Descriptive Statistics and Introduction to R. In fact, this course will telescope with MATH 170 and will consist eminently of Computer Labs dedicated to guiding he students in their preparation of the projects. The format of the course is highly non-conventional in that it will, in no small measure, consist of collective discussions and proposed resolutions of possible problems, difficulties and challenges met by students in the preparation of their project
Evaluation	50% CC, 50% CF

Course Title & Code	**UAE Studies - GEED- 101**
Instructor	Dr Kosmas Pavlopoulos – Dr Kévin Taillandier
Date	January – May 2024
Course Format	weekly class
Credits	0
Level	Undergraduate
Semester offered	2
Contact Hours	90 Total Time Commitment: 90
Course Description	• Physical Geography courses aim to understand how the Earth's physical environment of the UAE underlies and is affected by human activity over time. A holistic analysis of Earth systems and environmental change is attempted. This involves a representation of all environments in the UAE, including terrestrial, coastal, and marine, with case studies of the UAE's natural environment. The course will explore issues and challenges related to water resources and the energy transition in the context of sustainable development. • Human Geography courses examine a range of topics related to economic, urban, social, and cultural geography. Students will mobilise key geographical skills and materials to describe and critically analyse

	the impacts of globalisation on the UAE. Through oral presentations and face-to-face interviews, they will strengthen both their communication skills and their knowledge of where they live. History courses intend to explore the rich history of the UAE, beginning with the early history of the aera and the people, the cultural developments, and the drastic transformations of the territory between the 16th century and the 21st century
Evaluation	50% CC-50% CF

Course Details – L2

Course Title & Code	**Sequences and Series of Functions – MATH 220**
Instructor	Dr Samuel Feng –Dr Gianluca Mola
Date	September- December 2023
Course Format	weekly class
Credits	6
Level	Undergraduate
Semester offered	1
Contact Hours	60 Total Time Commitment: 60
Course Description	The course presents students with the essentials of the theory of numerical series and the series of functions theory. It starts with a detailed presentation of the criteria for the convergence of numerical series. Then, the theory of function sequences is presented. In particular, the notions of pointwise and uniform convergence are introduced and analyzed together with their relationship with continuity, differentiability and integrability. Relevant results for the analysis of general series of functions are also presented in this context. The second half of the course is dedicated to the detailed presentation of the theory of (complex-valued) power series and Fourier series. The course ends with some relevant applications in Sciences.
Evaluation	100%CC

Course Title & Code	**Topology and Analysis 1 - MATH 226**
Instructor	Dr Safaa Al Sayed
Date	September- December 2023
Course Format	weekly class
Credits	6

Level	Undergraduate
Semester offered	1
Contact Hours	60 Total Time Commitment: 60
Course Description	The course follows on the contents of MATH 200 and of MATH 160, introducing students first to the fundamental notions of Topology in $\mathbb{R}^n$ then to those of multivariable Analysis. Thus, in the first part of the course, students learn about different norms on $\mathbb{R}^n$ and their topological equivalence, the notions of open, closed, bounded, compact and connected sets as well as the topological definition of continuity. This part ends with the study of the fixed-point Theorem. In the second part of the course, the general theory of differential (real and vector valued) functions on $\mathbb{R}^n$ is presented. In particular, partial and directional derivatives, the Jacobian and the differential of a function, (continuously) differentiable functions, diffeomorphisms and parametric curves are studied in the first place. Next, the finite-increments formula is presented, followed by the multivariate Taylor formula. The course ends with a study of critical points in the interior of the domain of a differentiable map.
Evaluation	100%CC

Course Title & Code	**Linear and Bilinear Algebra 1 - MATH 222**
Instructor	Dr Lama Tarsissi
Date	September- December 2023
Course Format	weekly class
Credits	6
Level	Undergraduate
Semester offered	1
Contact Hours	60 Total Time Commitment: 60
Course Description	Following on the notions of determinants, eigenvalues, eigenvectors and on change of basis formulae, all of which are topics seen in L1, this course starts by treating eigenspaces and their use in characterizing diagonalizable operators, dual spaces and the associated notion of linear forms, highlighting its importance in differential calculus and in the representation of quadratic forms. The second part of the course consists of the study of Euclidean spaces (i.e. non-necessarily complete, inner product real vector spaces) in the framework of which the orthogonal group, the Gram-Schmidt orthogonalization procedure and the QR decomposition are presented. The third part of the course presents the general theory of symmetric bilinear forms, leading to the

	computation of the signature of a quadratic form. Finally, the fourth and last part of the course introduces pre-Hilbert complex spaces and Hilbert spaces.
Evaluation	100%CC

Course Title & Code	**Discrete Probability, Combinatorics and Graphs - MATH 250**
Instructor	Dr Miklos Ruszinko
Date	September- November 2023
Course Format	weekly class
Credits	12
Level	Undergraduate
Semester offered	1
Contact Hours	120 Total Time Commitment: 120
Course Description	The aim of this course is to provide students with the main structures of Discrete Mathematics and the typical tools from Probability Theory needed to model the introduction of randomness on these structures. In the first part, students are introduced to the main principles of enumeration and to basic combinatorial quantities, the progression in this part leading to teaching students to solve homogeneous linear recursions using formal power series. The second part of the course focuses on introducing and familiarizing students with graphs and trees, as well as the different structural properties that contribute to their characterization. In the third and last part of the course, after introducing the fundamentals of Probability Theory (probability spaces, conditional probability, random variables, moments) students will study some special topics/tools of relevance in the modelling of random discrete structures: probability generating functions, enumerative probabilities, introduction to random graphs.
Evaluation	100%CC

Course Title & Code	**Introduction to Probability Models - MATH 255**
Instructor	Dr Samuel Feng
Date	January – May 2024
Course Format	weekly class
Credits	6
Level	Undergraduate
Semester offered	2
Contact Hours	60 Total Time Commitment: 60
Course Description	The course constitutes a non-measure-theoretic introduction to Stochastic Processes. In the first part of the course, after a brief

	reminder of the main discrete and continuous laws, the theory of multivariate distributions is presented, leading to the treatment of conditional laws, conditional expectations and independence. In the second part of the course, a number of archetypical Stochastic processes, widely used in applications, are presented. In particular, the course develops a self-contained, introductory, albeit exhaustive, treatment of Branching processes, Random Walks, Markov Chains and Poisson processes and some of their principal applications
Evaluation	100%CC

Course Title & Code	**Lebesgue Integration Theory and Complements in Probability MATH 230**
Instructor	Dr Sudarshan Shinde – Dr Samuel Feng
Date	January – May 2024
Course Format	weekly class
Credits	9
Level	Undergraduate
Semester offered	2
Contact Hours	90 Total Time Commitment: 90
Course Description	The aim of this course is twofold: on the one hand, to provide students with a rigorous treatment of Real Analysis from the measure-theoretic point of view and a rigorous treatment of Probability Theory on Euclidean spaces. The connections between a measure-theoretic concept and its probabilistic counterpart will be constantly underlined all along the course, the aim being to put rigour on the intuitive notions seen in earlier and parallel Probability-based courses in L2. With this in mind, the course starts with the general definition of a sigma-field and of measures moving on to the construction of Lebesgue measure on $\mathbb{R}^n$. Moving from there, the notion of measurable function (random variable) is introduces and the Lebesgue integral is constructed (references to the probabilistic notions of expectation and moments are carefully made). Next, convergence theorems are presented, along with celebrated (measure theoretic and probabilistic) inequalities (Cauchy-Schwarz, Hölder, Markov, Chebyshev, etc.). The final part of the course touches on product measures, multiple integrals and Fourier transforms, hence on sequences of independent random variables, characteristic functions leading the way to the treatment of laws of large numbers and the Central Limit Theorem.
Evaluation	100%CC

Course Title & Code	**Linear and Bilinear Algebra 2- MATH 232**
Instructor	Dr Lama Tarsissi – Dr Gianluca Mola
Date	January – May 2024
Course Format	weekly class
Credits	6
Level	Undergraduate
Semester offered	2
Contact Hours	60 Total Time Commitment: 60
Course Description	Following on the notions of determinants, eigenvalues, eigenvectors and on change of basis formulae, all of which are topics seen in L1, this course starts by treating eigenspaces and their use in characterizing diagonalizable operators, dual spaces and the associated notion of linear forms, highlighting its importance in differential calculus and in the representation of quadratic forms. The second part of the course consists of the study of Euclidean spaces (i.e. non-necessarily complete, inner product real vector spaces) in the framework of which the orthogonal group, the Gram-Schmidt orthogonalization procedure and the QR decomposition are presented. The third part of the course presents the general theory of symmetric bilinear forms, leading to the computation of the signature of a quadratic form. Finally, the fourth and last part of the course introduces pre-Hilbert complex spaces and Hilbert spaces.
Evaluation	100%CC

Course Title & Code	**Multivariate Data Analysis- MATH 260 –**
Instructor	Dr Tanujit Chakraborty – Part Time Madhurima Panja
Date	January – May 2024
Course Format	weekly class
Credits	9
Level	Undergraduate
Semester offered	2
Contact Hours	90Total Time Commitment: 90
Course Description	The aim of this course is to provide students a general introduction to statistical methods for multivariate data analysis. The idea is to communicate to the students the statistical tools that are necessary to extract relevant information from any dataset. This course addresses several standard approaches like univariate and multivariate regression or principal components analysis. The students are expected to understand how these methods work, how to apply them on a new

	dataset and to interpret the outputs of the different algorithms. Students have to submit a project in which a practical problem has to be solved using the methods studied in the course.
Evaluation	100%CC

Course Details– L3

Course Title & Code	**Measure and Integration Theory - MATH 330**
Instructor	Dr Omar El Dakkak -Dr Sudarshan Shinde
Date	September- December 2023
Course Format	weekly class
Credits	6
Level	Undergraduate
Semester offered	1
Contact Hours	60 Total Time Commitment: 60
Course Description	The course starts with a more in-depth review of the notions seen in MATH 230 – Lebesgue Integration Theory and Complements in Probability Theory. More precisely, the course starts recalling the notion of a sigma-field and furthers the analysis of a Borel sigma-field on a topological space. Next, the notion of measure is recalled leading to the statement and proof of Caratheodory Theorem. From there, the general notion of an integral with respect to a measure is introduced and various convergence theorems recalled. In the final part of the course, signed measures, absolute continuity of a measure with respect to another and the Radon-Nikodym Theorem are presented. The course ends with a treatment of uniformly sigma-finite product measures and the Ionescu-Tulcea Theorem.
Evaluation	100%CC

Course Title & Code	**Topology and Analysis 2 - MATH 336**
Instructor	Dr Safaa Al Sayed
Date	September- December 2023
Course Format	weekly class
Credits	6
Level	Undergraduate
Semester offered	1

Contact Hours	60 Total Time Commitment: 60
Course Description	This aim of this course is to present some elements of Topology on metric spaces and some of their main applications in Analysis, namely on the theory of differential equations. The course starts with the definition of a metric space and of the notions of open, closed and dense subset of a metric space. Next, an introduction to Banach space (to be developed in detail in MATH 346 – Functional Analysis) is provided. Next the theory of compact metric spaces is presented, and the notions of completeness and connectedness treated in this level of generality. This part of the course ends with a detailed account on the local inversion theorem on Banach spaces and the Banach-Caccioppoli Theorem. A second part of the course will treat of the problem of the existence and unicity of a (maximal) solution of a differential equation (the Cauchy-Lipschitz Theorem).
Evaluation	100%CC

Course Title & Code	**Statistical Inference - MATH 350**
Instructor	Dr Tanujit Chakraborty – PT Madhurima Panja
Date	September- December 2023
Course Format	weekly class
Credits	12
Level	Undergraduate
Semester offered	1
Contact Hours	120 Total Time Commitment: 120
Course Description	The course is a classical advanced course in (parametric) Mathematical Statistics. The course uses the notions and tools developed in MATH 230 – Lebesgue Integration Theory and Complements in Probability Theory and in MATH 330 – Measure and Integration Theory. It starts with a study of the Glivenko-Cantelli Theorem and its connection with the general problem of estimation. Next, order statistics are studied (in the discrete and absolutely continuous cases) and the laws of well-known statistics are derived in the gaussian case. At this stage, the general theory of point estimation is presented within which the notions of unbiasedness, consistency and optimality are studied. A particular attention is given to maximum likelihood estimation. The next topics to be treated are confidence intervals and hypothesis testing. The course ends with an account on the linear model. In the framework of the course, a series of computer labs will be run on the following topics: simulations of random variables (by inversion, rejection sampling and by the Box-Muller transform) and Monte-Carlo methods in Statistics.
Evaluation	100%CC

Course Title & Code	**Numerical Analysis and Optimization - MATH 338**
Instructor	Dr Grace Younes
Date	September- December 2023
Course Format	weekly class
Credits	6
Level	Undergraduate
Semester offered	1
Contact Hours	60 Total Time Commitment: 60
Course Description	The course is divided into two parts: - The first part consists of an introduction to the basic algebraic structures of groups and rings. We focus on important classes of rings like integral domains, unique factorization domains, and principle domains. We also define polynomial rings where the coefficients of the polynomials are elements from a given field. We develop results concerning the divisibility and irreducibility of polynomials. - In the second part, we will develop some of the important concepts of number theory including many of those used in computer science. We will first introduce the notion of the divisibility of integers will prove many important results about modular arithmetic. We will discuss prime numbers and introduce the concept of greatest common divisors and study the Euclidean algorithm for computing them. We will explain how to solve linear congruences, as well as systems of linear congruences, which we solve using the famous Chinese remainder theorem. We introduce the subject of cryptography which plays an essential role in electronic communication. We will show how the ideas we develop can be used in cryptographical protocols, introducing protocols for sharing keys and for sending signed messages.
Evaluation	100%CC

Course Title & Code	**Advanced Probability Theory - MATH 355**
Instructor	Dr Samuel Feng –Dr Miklos Ruszinko
Date	January – May 2024
Course Format	weekly class
Credits	9
Level	Undergraduate
Semester offered	2
Contact Hours	90 Total Time Commitment: 90
Course Description	The course follows on from the notions acquired in MATH 230 – Lebesgue Integration Theory and Complements in Probability Theory and in MATH 330 – Measure and Integration Theory. It starts by a rigorous treatment the laws of large numbers and central limit theorems for triangular arrays. After a presentation of the theory of weak

	convergence, the multivariate central limit theorem is examined in detail. Next, the general theory of conditional expectation (given a sigma-field) is presented with a particular focus on the notion of regular conditional probability laws. The last third of the course is devoted to the treatment of some well-known stochastic processes: Discrete-time martingales and continuous-time Gaussian and stationary processes. The course ends with an introduction to Brownian motion
Evaluation	100%CC

Course Title & Code	**Functional Analysis - MATH 346**
Instructor	Dr Safaa Al Sayed
Date	January – May 2024
Course Format	weekly class
Credits	9
Level	Undergraduate
Semester offered	2
Contact Hours	90 Total Time Commitment: 90
Course Description	The course follows on ideally from MATH 330 – Measure and Integration Theory by developing standard notions of Functional Analysis. After recalling some well-known inequalities (Hölder, Minkowski, Jensen, etc.) the course properly starts with a rigorous treatment of normed vector spaces and Banach spaces. This leads to the study of L^p-spaces and various mathematical properties of such spaces (convergence, completeness, compactness, etc). The study of Hilbert spaces comes next with a particular attention to infinite-dimensional Hilbert spaces. In the last part of the course, Duality theory, convolutions and Fourier transforms on $\mathbb{R}^n$.
Evaluation	100%CC

Course Title & Code	**Data Science and Machine Learning - MATH 370**
Instructor	Dr Tanujit Chakraborty –Part Time Madhurima Panja
Date	January – May 2024
Course Format	weekly class
Credits	9
Level	Undergraduate
Semester offered	2
Contact Hours	120 Total Time Commitment: 120

Course Description	The aim of this course is to provide students a general introduction to data science and machine learning methods. The difference between statistics, data science and machine learning may sometimes feel unclear, because some methods are common to the three disciplines. The main idea is that statistics basically concern the estimation of parameters and their interpretation, whereas data science mainly deals with description and explanation of the data and machine learning with prediction. This course presents classical algorithms of optimization, classification and prediction. Students have to submit a project in which an industrial problem has to be solved using the methods studied in the course.
Evaluation	100%CC

Course Title & Code	**Integration to the World of Work 2 - MATH 301**
Instructor	Part -time Maria El Hassrouni – Part time Anita Roberts
Date	January – May 2024
Course Format	weekly class
Credits	3
Level	Undergraduate
Semester offered	2
Contact Hours	30 Total Time Commitment: 30
Course Description	In this course, students will explore their own self, career aspirations, and the world around them. They will be armed to harmoniously face a professional world that is in continuous evolution. They will reflect on their career. The course explores two aspects. The first aspect focuses on the individual, through self-assessment and learning skills such as writing a CV and presenting oneself. The second aspect focuses on global trends and their current and future impact on the individual, society and economy. More precisely, students learn how the world of work is changing. As a result, they are made aware of the nature of competencies that will be relevant in the future and how their newly acquired skillsets can be employed to foster a successful career. The specific case of physicists will be tackled along the course.
Evaluation	100%CC

Course Title & Code	**Languages – SCEN 101**

Instructor	Bassem Mehouachi
Date	September – December 2023
Course Format	weekly class
Credits	3
Level	Undergraduate
Semester offered	1 -2
Contact Hours	60 Total Time Commitment: 60
Course Description	This course covers the concepts and theories related to French Language skills, it includes reading, writing, speaking and listening learnings as well as grammar and engaging student in simple discussions on day to day topics. This course introduces the fundamental elements of the French language within a cultural context. Emphasis is on the development of basic listening, repeating, pronunciation, dictation, speaking, reading, and writing skills. Upon completion, students should be able to comprehend and respond with grammatical accuracy to spoken and written French as well as demonstrate cultural awareness. The method used is from the book Atelier A1: textbook and workbook. The level of knowledge the students should reach further to this course's sessions is half way towards A1 Level on the CEFR (French CECR) scale. There are 2 units, each unit will take around 10 to 12 hours to work through. At the end of each unit there are exercises to test the progress of students. These skills are reinforced by videos, songs, sketches, dialogues in situation. We use materials such as the Digital Back, to facilitate the acquisition of these skills.
Evaluation	100%CC

Permanent Academic and Administrative Staff

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Permanent Faculty :

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Dr. Eliane Bsaibess
Dr. Gianluca Mola
Dr. Grace Younes
Dr. Omar El Dakkak
Dr.Lama Tarsissi
Dr. Samuel Feng
Dr. Safaa Elsayed
Dr. Sudarshan Shinde
Dr.Tanujit Chakraborty
Dr.Miklos Ruszinko

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