COURSE FRAMEWORK – ARTIFICIAL INTELLIGENCE: FROM COLLEGE MATH TO INTELLIGENT SYSTEMS

GENERAL INFORMATION

COURSE TITLE				COURSE NUMBER
ARTIFICIAL INTELLIGENCE: FROM COLLEGE MATH TO INTELLIGENT SYSTEMS				201-SND-VA
PROGRAM CODE AND TITLE				PROGRAM COMPONENT
200.B1 Science and 200.C1 Computer Science and Mathematics				Program-specific (Pre-U)
PREREQUISITES	SEMESTER	PONDERATION	TOTAL CONTACT HRS	TOTAL HOMEWORK HRS
201-SN2-RE Pre- or Co- requisite: 201-SN4-RE, 420-SN1-RE	3-4	2-2-2	60	30

COURSE'S ROLE IN THE PROGRAM

This course presents the mathematical foundations of machine learning and artificial intelligence. Students will deepen their understanding of the core mathematical tools: linear algebra, probability, optimization, and calculus, and see how these underpin algorithms such as regression, classification, and neural networks. The emphasis is on deriving methods, analyzing their behavior, and critically applying existing models. Students will develop both theoretical insight and the ability to apply established AI methods responsibly and effectively.

COURSE-LEVEL LEARNING OUTCOME

Upon completion of this course, students will be able to articulate the core principles of machine learning (ML) and artificial intelligence (AI), explain the mathematical foundations underlying key models, and critically apply existing ML/AI methods to analyze data and evaluate outcomes in real-world contexts.

KEY LEARNING OUTCOMES

Students will be able to:

1. Apply and evaluate machine learning models, such as regression, classification, and ensemble methods, using their underlying mathematical principles.
2. Explain the mathematics of neural networks and train standard architectures for tasks such as image recognition and natural language processing, using existing frameworks.
3. Use and critically assess generative models, interpreting results in light of their mathematical formulation and limitations.
4. Analyze and discuss the ethical and societal implications of AI technologies with reference to their mathematical assumptions and consequences.
5. Apply reinforcement learning methods to decision-making problems, analyzing the mathematical foundations of value functions and policies. (optional)

LEARNING INTEGRATION ASSESSMENT (LIA)

The LIA for this course will be a student project in which learners apply an existing Machine Learning or Neural Network model to a realistic dataset, evaluate its performance, and analyze the mathematical concepts underlying the model's behavior.

EVALUATION CRITERIA FOR THE LEARNING INTEGRATION ASSESSMENT

- Problem Definition and Dataset Understanding
  - Clarity in articulating the problem statement.
  - Demonstration of understanding the mathematical and contextual relevance of the chosen realistic dataset.
- Integration of Theoretical Concepts
  - Clear connection between theoretical ML/AI concepts (linear algebra, calculus, probability, optimization) and practical implementation.
  - Evidence of applying fundamental principles in model choice, analysis, and problem-solving.
- Data Preparation and Feature Engineering
  - Effective data cleaning and preprocessing.
  - Appropriate feature selection or engineering that reflects an understanding of the underlying mathematical structure of the problem.
- Model Selection and Implementation
  - Justification for choosing specific ML or Neural Network models, grounded in their mathematical properties.
  - Correct usage of the chosen model(s) aligned with the problem requirements.
- Performance Evaluation and Analysis
  - Use of suitable performance metrics, including interpretation in terms of probability/statistics.
  - Critical analysis of results, with discussion of limitations, assumptions, and potential improvements.
- Communication and Presentation
  - Organization and clarity in presenting findings, including visualizations and mathematical interpretations.
  - Professional and coherent documentation of the project process and outcomes.

Indicate in the box, the percentage of the final grade that the LIA will be worth.

WEIGHT OF GRADE (%)
20-30%

COMPETENCIES AND TRANSVERSAL LEARNING				
CODE	COMPETENCY STATEMENT	PROGRESSION	HOURS	OTHER COURSES CARRYING THE COMPETENCY
OGNF	Consolidate one's scientific culture in a scientific field	Comprehensive	60	Oodles : Consolidating one's scientific culture is a transversal competency that is reinforced throughout the curriculum.

TRANSVERSAL LEARNING

- Critical thinking, problem solving and logical reasoning
- Note-taking and study skills
- Communication skills, both oral and written
- Consistency and rigour in problem-solving, and justification of the approach used
- See connections between mathematics, science and technology through an interdisciplinary approach to certain problems
- Digital Literacy and ICT Proficiency: Ability to effectively use digital tools and technologies for data analysis, communication, and research, supporting learning and problem-solving across disciplines.

STUDENT PROFICIENCY IN THE LANGUAGE OF INSTRUCTION (SPLI)

Student proficiency in the language of instruction is the ability to write, read, speak, and listen in order to communicate effectively at the college level. SPLI may also require discipline-specific vocabulary, documentation, and communication skills; assessment of language skills must account for a minimum of 10% of any take-home written assignment or oral presentation in which English is the language of expression.

In general, mathematics assessments do not require extensive use of English by the student. Instead, students primarily use symbolic manipulations, graphical representations and code to solve problems. When students use English, they typically use it only in isolated words or sentence fragments. However, when a substantive written report or oral presentation is evaluated, the SPLI policy will apply to the evaluation of that component.

PEDAGOGICAL STRATEGIES AND ASSESSMENTS

Key assessments:

- In-class quizzes and tests, Jupyter/Google Colab Notebook exercises, and collaborative problem-solving sessions
- A final exam, and a project (integrative assessment) evaluate both theoretical understanding and practical application

Key learning activities

- Interactive lectures, group assignments, individual homework, and hands-on coding labs

Pedagogical Strategies:

- Classic lectures, scaffolded learning, flipped classroom sessions, and problem-based learning using industry case studies

Recommended books:

- Bishop, C. M., & Bishop, H. (2023). Deep learning: Foundations and Concepts. Springer.
- Zhang, A., Lipton, Z. C., Li, M., & Smola, A. J. (2021). Dive into Deep Learning. ArXiv (Cornell University)
- Prince, S. J. D. (2023). Understanding deep learning. The MIT Press. http://udlbook.com

APPENDIX 1 – EXCERPT OF THE MINISTERIAL *DEVIS:*

Code: 0GNF

Objective	*Standard*
Statement of the Competency	**Performance Criteria for the Competency as a Whole**
Consolidate one's scientific culture in a scientific field.	• Appropriate use of terminology • Appropriate use of necessary computer tools

Elements of the Competency	**Performance Criteria**
1. Identify concepts specific to the chosen field.	• Appropriate characterization of relevant concepts • Accurate association of concepts to their field of application
2. Solve problems specific to the chosen field.	• Accurate application of the relevant concepts, laws and principles • Rigorous application of a procedure adapted to the problem • Clear presentation of problem-solving steps • Accurate interpretation of results
3. Demonstrate the contribution of the field to understanding scientific issues.	• Clear delimitation of a relevant problem involving scientific issues • Accurate application of concepts, laws and principles relevant to the problem • Establishment of relevant connections between the field and the scientific issues studied

Learning Activities	
Disciplines:	Biology, chemistry, computer science, geology, mathematics, physics
Periods of instruction:	At least 60

Code : 0GNF

Objectif	*Standard*
Énoncé de la compétence	**Critères de performance liés à l'ensemble de la compétence**
Consolider sa culture scientifique dans un domaine des sciences de la nature.	• Utilisation appropriée de la terminologie. • Utilisation appropriée des outils informatiques requis.

Éléments de la compétence	**Critères de performance**
1. Distinguer les concepts propres au domaine à l'étude.	• Caractérisation appropriée des concepts pertinents. • Association juste des concepts à leur champ d'application.
2. Résoudre des problèmes propres au domaine à l'étude.	• Application juste des concepts, des lois et des principes pertinents. • Application rigoureuse d'une démarche adaptée au problème. • Présentation claire des étapes de résolution de problèmes. • Interprétation juste des résultats.
3. Démontrer la contribution du domaine à la compréhension d'enjeux scientifiques.	• Délimitation claire d'une problématique pertinente liée aux enjeux scientifiques. • Application juste des concepts, des lois et des principes appropriés à la problématique. • Établissement de liens pertinents entre le domaine et les enjeux scientifiques étudiés.

Activités d'apprentissage	
Discipline :	Biologie, chimie, géologie, informatique, mathématique, physique
Périodes d'enseignement :	Au moins 60

APPENDIX 2 – COURSE DESCRIPTION

This course explores the mathematical foundations of Machine Learning (ML) and Artificial Intelligence (AI). Starting from core ideas such as regression and classification, students will see how concepts from linear algebra, calculus, probability, and optimization power modern AI systems. Building on this foundation, we will study advanced topics including neural networks, deep learning, and reinforcement learning. Hands-on projects will give students experience designing and evaluating AI models, while discussions of ethics and real-world impact will connect the math to today's societal challenges.