Artificial Intelligence in Civil Engineering

1. **Course number and name:** 020IAGGS4 Artificial Intelligence in Civil Engineering

2. **Credits and contact hours:** 2 ECTS credits, 1x1.25 hours

3. **Name(s) of instructor(s) or course coordinator(s):** Rafic FADDOUL

4. **Instructional Materials:** PowerPoint slides; Colaboratory Python Notebooks, course handouts.

5. **Specific course information**
   a. **Catalog description:** Introduction aux méthodes d'apprentissage machine (Machine Learning) et d'intelligence artificielle et plus particulièrement à l'apprentissage profond. Le cours comportera des notions sur : Arbres de Décisions - Réseaux neuronales profonds denses multicouches – Réseaux convolutifs – Transformeurs – Traitement automatique du langage naturel – Menaces de l'AI – Pytorch.

   b. **Prerequisites or co-requisites:** None

   c. **Required:** Restricted Elective

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**
   - Understand the Fundamental Mechanisms of Deep Learning Algorithms: Gain a comprehensive understanding of the core principles, architectures, and mechanisms underlying deep learning models. This includes exploring activation functions, backpropagation, convolutional neural networks (CNNs), recurrent neural networks (RNNs), and the role of loss functions and optimizers in model training.
   - Develop Artificial Neural Networks (ANNs) with PyTorch for Engineering Applications: Acquire hands-on experience in designing, training, and implementing ANNs using the PyTorch framework to address real-world engineering challenges. Emphasis will be placed on data preprocessing, model selection, hyperparameter tuning, and performance evaluation to ensure the development of robust and efficient solutions.
   - Assess the Security Risks and Threats Associated with AI Systems: Delve into the security aspects of AI, focusing on identifying potential vulnerabilities and threats that arise from the deployment of AI systems. Topics will include adversarial attacks, data poisoning, model theft, and strategies for securing AI systems against malicious use.
   - Explore the Ethical Considerations and Responsibilities in AI Development: Engage in a critical analysis of the ethical dimensions of AI, including bias, fairness, transparency, accountability, and privacy. Discussions will aim to foster responsible AI development practices that respect human rights and promote equitable outcomes across diverse societal contexts.

b. PI addressed by the course:

PI	1.2	1.4	2.3	4.1	6.3
Covered	yes	yes	yes	yes	yes
Assessed					

7. Brief list of topics to be covered:

- Backpropagation (1h)
- Optimization (1h)
- Fully connected neural networks (3h)
- Convolutional neural networks (2h)
- Ethics of AI (2h)
- Threats of AI (2h)
- History of AI (1h)
- Embeddings and semantic search (4h)
- Large language models (2h)