[Course Title] Scientific Machine Learning for Infrastructure Systems

[Course Code] CIVL 4220

[No. of Credits] 3

[pre-/co-requisites] MATH2111 or MATH 2121 or MATH 2131 or MATH 2350 AND

COMP1021 or COMP 1022P or COMP 1029P

Name: Jize ZHANG

Email: cejize@ust.hk

Course Description

Scientific machine learning (ML) seeks to address domain-specific data challenges and extract insights from scientific data sets through innovative methodological solutions, and this course aims to introduce scientific ML to senior students with a special focus on civil engineering applications. The course starts with an extensive review of statistics, the difference between ML and descriptive statistics, discusses sampling approaches for uncertainty quantification, then covers the fundamental knowledge of supervised learning (Bayesian linear regression, Gaussian processes, deep neural networks), unsupervised learning (k-means clustering, principal component analysis, Gaussian mixtures), and state space models (Kalman, particle filters). The course will further emphasize on the proper use of ML for civil engineering applications, including incorporating physics-based knowledge (physics-informed ML), dealing with data acquisition challenges (design of experiment, global optimization), and so on. Students will learn to address some unique challenges of applying ML to real-world engineering applications, preparing themselves better in their future career.

Assessments:

Assessment Task	Contribution to Overall Course grade (%)
Homework	30%
In-course Participation	5%
Literature Review	25%
Final Project	40%

Required Texts and Materials

Kevin P. Murphy. 2022. *Probabilistic Machine Learning: An Introduction*, MIT Press,

Ian Goodfellow, Yoshua Bengio, and Aaron Courville. 2016. *Deep Learning*, MIT Press,

Christopher Bishop. 2006. *Pattern Recognition and Machine Learning*, Springer.

[Optional] Additional Resources

[List any additional resources, such as online platforms, library resources, etc.]