Programme	Bachelor of Science in Physics		
Course Title	Contemporary Applications of Physics: Machine Learning in Physics	**Course Code**	PHYS4811
QF Level	5	**Credit Units**	1
Semester	Fall 2024-2025	**Time / Week**	Wednesday, 16:30 – 17:50 Friday, 16:30 – 17:50
Instructor	Dr. Wilson Woon (wilsonwoon@ust.hk)	**Venue**	Room 1409

Course Objective

This course aims to provide students with a fundamental understanding of machine learning and its applications in Physics.

Pre-requisites

PHY 2022 and (PHYS 3142 or MATH 3312) and MATH 2023.

Course Intended Learning Outcomes (CILOs):

After completing this course, students should be able to:

1. understand machine learning's fundamental concepts and principles.
2. apply appropriate machine learning algorithms in Physics applications.

Bring Your Device (BYD):

Students are required to bring their laptops or tablets to class, equipped with a web browser, Microsoft Excel, and access to the Internet. It is important to note that all the course materials have been tested to run well on Windows 11. If you use another operating system or another version of Windows, the course materials may not work. You are responsible for finding a solution to this problem.

Assessment and Grading

This course will be assessed using criterion-referencing, and grades will not be assigned using a curve. Detailed rubrics for each assignment are provided below.

Performance Evaluation

The course will be graded using the conventional letter grading system found HERE. Students must achieve a minimum score of 50% to obtain a marginal pass (D grade).

Assessment	Percentage of Grade	CILOs assessed
Final Project	100%	1, 2
Total	100% (100 points)	

Penalty for Late Submissions:

- 1 day: -20%
- 2 days: -40%
- 3 days or later: -100%

Readings/References:

1. J. Avila and T. Hauck (2017) Scikit-learn cookbook : over 80 recipes for machine learning python with scikit-learn, Packt Publishing. (Access via UST internal network: https://lbdiscover.hkust.edu.hk/bib/991012884408603412)
2. K. T. Schütt, S. Chmiela, O. A. von Lilienfeld, A. Tkatchenko, K. Tsuda, Klaus-Robert Müller (2020) Machine Learning Meets Quantum Physics, Springer. (Access via UST internet network: https://lbdiscover.hkust.edu.hk/bib/991012828013903412)
3. K. Eremenko and H. de Ponteves. Machine Learning A-Z™: AI, Python & R. Udemy Online Course. Available from https://www.udemy.com/course/machinelearning/
4. Simplilearn, "What is Artificial Intelligence?". Available from https://www.youtube.com/watch?v=uMzUB89uSxU

HKUST Code of Honour

Students must be aware of University policy and regulations on honesty in academic work and of the disciplinary guidelines and procedures applicable to breaches of such policies and regulations, as contained in https://registry.hkust.edu.hk/resource-library/academic-integrity.

Code of Conduct on the Use of Generative AI

The use of Generative AI is generally encouraged. However, students must understand its limitations and drawbacks. Proper acknowledgements about the use of this tool must be provided in each submitted assessment task.

Accommodation for Students with Special Needs

Students with special needs should inform the instructor of their needs at the beginning of the semester so that appropriate accommodations can be provided.

Tentative Teaching Plan

The following teaching plan is **subject to change**. Please check back from time to time.

Date	Topic	Readings	Notes/Due dates
Wed, 4 Sept	• Course Outline & Introduction • Artificial Intelligence: The Big Picture • Setting-up	4	
Fri, 6 Sept	Supervised Learning – Regressions		
Wed, 11 Sept	Supervised Learning – Evaluation & Regressions	1, 3	
Fri, 13 Sept	Supervised Learning - Classifications	1, 3	Release Final Project
Wed, 18 Sept	Mid-Autumn Festival Holiday – No lesson		
Fri, 20 Sept	Unsupervised Learning	1, 3	
Wed, 25 Sept	Cross Validation & Grid Search	1, 3	

	Reinforcement Learning Part 1		
Fri, 27 Sept	Project Work Reinforcement Learning Part 2		Final Project Due on Monday, 30 Sept
Mon, 30 Sept	Q&A with your TA		

Project Assignment Grade Descriptor

Grade / Grade Range	Criteria
A+, A	• Solid understanding of the chosen application of Machine Learning in Physics. • Excellent research on the application and related Machine Learning algorithm(s). • The case study is well-structured and demonstrates strong coherence in all sections. • Rigorous analysis of how Machine Learning solves the Physics problem. It includes Mathematical formulations with clear explanations. **Demonstrating innovation by solving an unresolved or new problem**. • Real dataset with rigorous analysis is included. • Used advanced evaluation metrics and analyses, including parameter selection and boosting. • No grammatical errors. • Proper citations and acknowledgement are included in all submissions. A minimum of four citations are needed.
A-	• Solid understanding of the chosen application of Machine Learning in Physics. • Good research on the application and related Machine Learning algorithm(s). • The case study is well-structured and demonstrates good coherence in all sections. • **Empirical evaluation results are included in the discussion**. • No grammatical errors. • Proper citations and acknowledgement are included in all submissions. A minimum of four citations are needed.
B+	• Adequate understanding of the chosen application of Machine Learning in Physics. • Adequate research on the application and related Machine Learning algorithm(s). • The case study is well-structured and demonstrates good coherence in some sections. • Reasonable analysis of how Machine Learning is used to solve the Physics problem. • Minor grammatical errors. • Proper citations and acknowledgement are included in all submissions. A minimum of three citations are needed.
B	• Basic understanding of the chosen application of Machine Learning in Physics. • Limited research on the application and related Machine Learning algorithm(s).

	• The case study lacks structure and coherence in some sections. • Superficial analysis of how Machine Learning solves the Physics problem. • Some grammatical errors. • Proper citations and acknowledgement are included in all submissions. A minimum of three citations are needed.
B	• Basic understanding of the chosen application of Machine Learning in Physics. • Limited research on the application and related Machine Learning algorithm(s). • The case study lacks structure and coherence in some sections. • Superficial analysis of how Machine Learning solves the Physics problem. • Many grammatical errors. • Proper citations and acknowledgement are included in all submissions. A minimum of three citations are needed.
C+	• Basic understanding of the chosen application of Machine Learning in Physics. • Limited research on the application and related Machine Learning algorithm(s). • Case study lacks structure and coherence in some sections. • Superficial analysis of how Machine Learning solves the Physics problem. • Many grammatical errors. • Lack of citations. • **Extensive use of Generative AI to generate the report but with some effort in rewriting and paraphrasing.**
C	• Low understanding of the chosen application of Machine Learning in Physics. • Limited research on the application and related Machine Learning algorithm(s). • The case study lacks structure and coherence in most sections. • Low analysis of how Machine Learning is used to solve the Physics problem. • Many grammatical errors. • Lack of citations • **Extensive use of Generative AI to generate the report.**
C-	• Incomplete submission, but key messages were communicated.
D	• Incomplete submission and key messages were unclear or lacking
F	• No submission. • Submitted the wrong file(s) or wrong project. • Plagiarism.