香 港 大 學
THE UNIVERSITY OF HONG KONG

The semester and year that the course is expected to be offered as a CI-Badged Course

Communication-intensive Course (CI Course) Certification Form

Course Code	Course Title	Course Coordinator	Expected Offering Year & Semester	Badging Type	
PHYS3151	Machine learning in physics	Prof. Zi Yang Meng	Sem 2, 2023-24	☑	**New Course**
				☐	**Renewal**

Communication 'Literacies' - In which literacy areas do students on the course develop and demonstrate communication-related *knowledge* (understanding of communication as it relates to human interaction), *skills* (skills in communicating effectively with others, using language and/or other means) and *attributes* (the attributes of effective communicators)? Please select at least two and put a tick (✓) in the boxes.

✓	***Oral literacy*:** The ability to communicate through spoken texts that are constructed with the appropriate content, structure and language features, fit for their intended academic, social or professional purpose and audience.
✓	***Written literacy***: The ability to communicate through written te… appropriate content, structure and language features, fit for their intended a… urpose and audience.
✓	***Visual literacy***: The ability to communicate in speech and writing through appropriate visual modes (e.g., diagrams, graphs, charts) and/or visual media (e.g., posters, 3-D printed objects, stage performances).
✓	***Digital literacy***: The ability to use appropriate information and communication technologies to find, evaluate, create, and communicate information in speech and writing (e.g., wikis, websites, virtual reality projects).

Ensure that each selected literacy is explicitly taught and assessed in the course.

Course Learning Outcomes – Please list the course learning outcome(s) that relate explicitly to students' learning of communication-related knowledge, skills and attributes. The following are examples from four different courses:

Students will be able to…

Oral literacy: *A… sed interviewing and counselling and demonstrate interviewing and counselling ski…*

Written/visual … *literature review on a key regional geological issue and present the findings throug… gaging, comprehensive online written format.*

Oral/written literacy: *Generate and refine designs into detailed engineering specifications and be able to effectively communicate and defend the project status and technical material in both oral and written forms.*

Oral/written/digital literacy: *Create design documentation, technical design documents, art 'bibles' and other pertinent technical documents and present these through a formal pitch presentation and website.*

Copy and paste from your course outline and modifying to clearly show communication literacies.

Students will be able to…
[CLO 1]: demonstrate knowledge in essential methods and techniques for machine learning and its application in physics through oral, written visual and digital means

[CLO 4]: use of effective digital visual and verbal communication skills through oral presentation

Assessment component – Please list the communication-rich assessment task(s) that measure the communication-related course learning outcomes on the course. Please indicate what proportion of the course grade is allocated to performance on the assessment(s).

Written Assignments (x3) (30%,digital)
Students are required to individually solve 3 sets of problems. There are three assignments, each worth 10%. They need to compose codes, run them for results, make some plots to show their results and provide a written explanation to describe and explain their results. After obtaining the result from codes, students also need to provide a short, written elaboration on their own improvement on the algorithm, the significance of their results, as well as the logic behind their coding.

Project Reports (x2) (20%, Digital, Written& Visual)
Students are required to individually solve 2 sets of problems and produce 2 reports, each worth 10%. Compared to usual assignments, these problems rely more on critical thinking, the ability to solve problems and state one's own findings. Some problems require students to run and compare different algorithms and describe the pros and cons of them. Students are required to run their code, present their findings with necessary plots and words.
Besides those also done in the assignments, the projects provide platforms for them to think critically. They have the flexibility to experiment with different algorithms and comment on their respective superiorities.

Project Presentations (x2) (20%, Oral & & Digital, Visual)
After completing the individual project, students are required to deliver 2 presentations in groups on their results on the project problems as well as how they solve them. There are 2 presentations, each worth 10%. They are required to make a presentation PowerPoint, which includes plots, some words of reasoning and their results.
For each presentation, students are required to form groups of 2, and deliver a talk for around 10 minutes, followed by a Q&A section where professor, tutor and other students can express their opinions.

Presentation Skill (6%): Being able to present fluently and clearly in front of the class.
PowerPoint Organization (6%): Being able to organize their finding and plots in their presentation PowerPoint.
Content (8%): Being able to answer all questions correctly and provide reasoning. Extra points will be given for those who provide a novel approach in solving problems.

Total Assessment Components Weighting: 70%

Please only include the CIC related assessments. Indicate the percentage in brackets *and include a brief description of each CIC related assessment.*

Please refer to sample CiC Syllabus Statements to complete this section. After badging approval, this section will appear in your course syllabus and read by students.

What communication knowledge and skills will students learn in this course?

Students will learn oral, written and visual and digital communication skills.

Oral Literacy
Students will learn how to clearly explain the algorithms they have learned and implemented to their classmates and the tutor. The students will also learn features of successful oral presentations such as body language, eye contact. Students will learn how to avoid relying on a script and to present more naturally using spontaneous English.

Written Literacy
Students will learn how to write a short research style paper (Proje
understanding of the algorithms they have learned and the physics
different sections of the report and what information belongs in ea

The answers to these questions will appear in the CiC Badge. The CiC Badge must be included in the course outline to inform students that they are taking a CiC Course.

Visual Literacy
Students will learn how to present data in a range of visuals such as charts, plots and animation. They will also learn how to design useful legends, labels and titles for these visuals.

Digital Literacy
Students will learn how to program in Python. This will be done as a lab session and students will be able to ask the teacher for guidance and assistance.

More specifically, oral communication skills include presenting one's own research finding in a clear and logical manner. Written communication skills include summarizing and explaining one's own finding in a written report. Visual communication skills include making plots for related variables with appropriate legends, labels and titles.

How will students learn these? Describe (1) the teaching and learning activities in your course that teach the communication knowledge and skills, (2) practice activities in your course and (3) opportunities for formative feedback

Oral Literacy
Students learn oral presentation skills through in-class lectures and tutorials (feedback on student presentations). Students need to deliver 2 assessed presentations during the course. They are expected to use the teacher feedback on the first presentation in the second presentation. Students will have a mock presentation before the first oral presentation in which the teacher will provide feedback on oral presentation skills.

Written Literacy
Students learn report writing skills through in-class lectures and tutorials (feedback on student work). Exemplars of report sections will be shown to students.

Students need to write 2 reports during the course. They are expected to use the teacher feedback on the first report in the second report.

Visual literacy
Students learn how present different kinds of data through in-class lectures and tutorials (feedback on student work). Students will be shown a range of exemplars of different kinds of visuals. These visuals will be included in the written reports and oral presentations. Students will be given feedback on use of visuals in the Written Assignments (x3) and the Project Reports (x2). They are expected to make improvements to the later assignments based on the teacher feedback in the earlier assignments.

Digital Literacy
Students will learn how to program in Python through cloud computing during the class in the form of a lab session. Students practice their coding skills are given feedback on these by the teacher. Students are also given feedback on their coding skills in tutorials. There are three coding assessments during the course. Students receive feedback on the first and second assignments from the class teacher and are expected to use the feedback in the subsequent assignments. The teacher will also provide general feedback to the class on Written Assignment 1 and Written Assignment 2 in a tutorial.

Students will learn written and visual communication skills in completing homework and project reports. Students are required to provide necessary words of reasoning and make plots to describe and explain their result of code. Data visualization makes up for a significant portion in each assignment (~40%). Students are required to make plots to show their findings, with appropriate l legends, labels and titles. A general introduction on making plot with Python is taught in the first assignment, along with other basic coding knowledge.

Oral communication skills in learnt in the project presentations. They will receive comments on their presentation skills and contents of PowerPoint before and after both presentations. Also, working as a group on projects will require students to communicate with each other about their opinion. In the grading of the presentation, students will be required to not only show correct results, but also present them in a clear and confident manner.

-**Support**:

- A mock presentation is held before each presentation. The tutor will give them feedback to help them improve their presentation skills and content including data visualization. This includes their PowerPoint designing, quality of data visualization, fluency of their spoken English and their logic flow.
- Some comments are given to each student after their presentations, either on their presentation skills, or on their contents, i.e., whether they are well-organized so as to demonstrate their point of view.
- They are able to enhance their presentation skill after gaining experience and suggestion in the first presentation and show their improvement in the second presentati
- The tutor will answer their questions on the proje ormance after grading.

The answers to these questions will appear in the CiC Badge. The CiC Badge must be included in the course outline to inform students that they are taking a CiC Course.

What does a good communicator look like in this course? – Please list the expected communication-related attributes you want your students to have after taking your course (e.g. confidence, openness to diverse perspectives and ways of learning, ability to respond to constructive criticism from peers and the teacher, developing interpersonal skills to collaborate with others to achieve a common goal, collaboration with peers, providing constructive feedback to peers, following the conventions of a genre, and having personal and academic integrity).

In fulfilling the course assessment, the students are required to

- Communicate and work with a partner in the projects.
- Explain their result of codes in written and in oral.
- Make clear plots to demonstrate their results.
- Present their own findings in front of the whole class.

Please attach the following documents with this certification form (tick included items):

	Please tick below
Course Syllabus (track changes version)	✓
Course Schedule (please highlight the CIC components i.e. where and when in the course the students will acquire the specific knowledge, and develop the specific skills required of a good communicator)	✓
Assessment Tasks/Instructions and Rubrics	✓

Submit all documents to the CIC committee (cics@hku.hk).

PHYS3151 Machine Learning in Physics

Course Objectives

Machine learning is a technique that enables computers to learn without being explicitly "programmed''. It is an essential part of big data science and has been widely used in different fields of physics. This course introduces the basics of machine learning, from key concepts to practical algorithms, with a focus on real-world applications in physics. It is an elective course for the computational physics theme. This is also an essential course for those who plan to apply machine learning techniques in their postgraduate studies such as condensed matter physics and astrophysics or in their future work.

Course Contents & Topics

Machine learning software packages in Python, Supervised and Unsupervised learning, Regression, Classification, Principal component analysis, Singular value decomposition, Support vector machines, Clustering, K-Nearest Neighbors, Neural Networks, Deep Learning, Application of machine learning in physics research with examples drawing from fields such as condensed matter physics, quantum material, astrophysics, particle physics and complex systems.

Course Learning Outcomes

On successful completion of this course, students should be able to:

[CLO 1] demonstrate knowledge in essential methods and techniques for machine learning and its application in physics through oral, written, visual and digital means
[CLO 2] apply the techniques of machine learning in data analysis
[CLO 3] use Python machine learning packages to solve simple problems
[CLO 4] use of effective digital, visualand verbal communication skills through oral presentation

CiC related CLOs, these must match with CIC Certification form P.1

Assessment Methods and Weighting

Assignments: 30% (badged for CIC)
- 3 assignments containing coding, summarizing own result and providing some words of reasoning. For the result of code, some plots is needed to shows

Examination: 30% (not badged for CIC)
- One 2-hour exam

Presentation: 20% (badged for CIC)
- Students need to complete 2 project (individually or in group of two people) and present their own finding in front of the whole class.

Project report: 20% (badged for CIC)
- Students need to complete 2 projects, and write a report on their own finding.

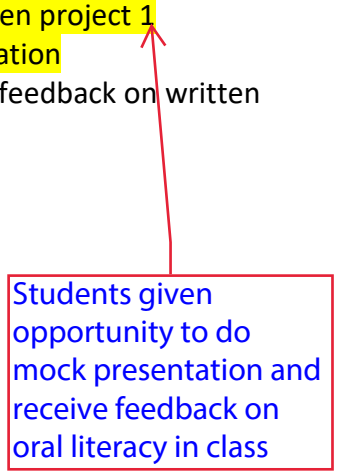
Course Co-ordinator: Dr Zi Yang Meng

Students learn and practice digital literacy in class

Clear discription on how CiC Components will be taught

Date	Lecture Topics	CIC activities
Week 1	Introduction to the course, assessment, and content. Multivariate Linear Regression	Digital Literacy: Students use cloud computing to learn and practice Python. This is done as a lab session.
Week 2	Multivariate Linear Regression continued	Digital Literacy: Students use cloud computing to learn and practice Python. This is done as a lab session.
Week 3	Multivariate Linear Regression continued Regularization	Digital Literacy: Students use cloud computing to learn and practice Python. This is done as a lab session.
Week 4	Logistic Regression Due date of Written assignment 1	Digital Literacy: Students use cloud computing to learn and practice Python. This is done as a lab session. Written Literacy: Students will learn how to write a short research style paper which clearly and accurately presents their understanding of the algorithms they have learned and the physics problems they have solved. They will learn how to write different sections of the report and what information belongs in each section. This is done in lecture format. Exemplars of report sections will be shown to students.
Week 5	Logistic Regression continued Tutorial: General feedback on written assignment 1	Digital Literacy: Students use cloud computing to learn and practice Python. This is done as a lab session.
Week 6	Support Vector Machine Due date of Written assignment 2	Digital Literacy: Students use cloud computing to learn and practice Python. This is done as a lab session.
Week 7	Reading week, no lecture	Digital Literacy:

Students receive feedback on written literacy in class

Date	Lecture Topics	CIC activities
		Students use cloud computing to learn and practice Python. This is done as a lab session.
Week 8	Mock section for presentation 1 (teacher gives feedback on oral presentation skills) Due date of Written project 1 Project 1 presentation Tutorial: General feedback on written assignment 2  	Digital Literacy: Students use cloud computing to learn and practice Python Oral literacy: Students will learn how to clearly explain the algorithms they have learned and implemented to their classmates and the tutor. The students will also learn features of successful oral presentations such as body language, eye contact. Students will learn how to avoid relying on a script and to present more naturally using spontaneous English. This is done in lecture format. Visual Literacy: Students will learn how to present data in a range of visuals such as charts, plots and animation. They will also learn how to design useful legends, labels and titles for these visuals. This is done in lecture format. Students will be shown a exemplars of a range of different visuals.
Week 9	Principal Component Analysis Clustering Tutorial: General feedback on written project 1	Digital Literacy: Students use cloud computing to learn and practice Python. This is done as a lab session.
Week 10	Clustering continued	Digital Literacy: Students use cloud computing to learn and practice Python. This is done as a lab session.
Week 11	Neural Networks Due date of Written assignment 3	Digital Literacy:

Date	Lecture Topics	CIC activities
		Students use cloud computing to learn and practice Python. This is done as a lab session.
Week 12	Neural Networks continued	Digital Literacy: Students use cloud computing to learn and practice Python. This is done as a lab session.
Week 13	Neural Networks continued	Digital Literacy: Students use cloud computing to learn and practice Python. This is done as a lab session.
Week 14	Mock section for presentation 2 Due date of Written project 2 Project 2 presentation	Digital Literacy: Students use cloud computing to learn and practice Python. This is done as a lab session. Written Literacy:

PHYS3151 Machine learning in physics
CiC Assessment Tasks/Instructions and Rubrics

(I) Instructions for Assignment

- Students need to submit 3 short reports for 3 assignments separately.
- The report should be semi-formal to answer all the assignment questions by performing both numerical simulation and analytical analysis.
- Figures are required to present the result with clear legend and tick labels. Necessary explanations and analysis are required to ensure a logical flow and convince the readers.

Grading criteria

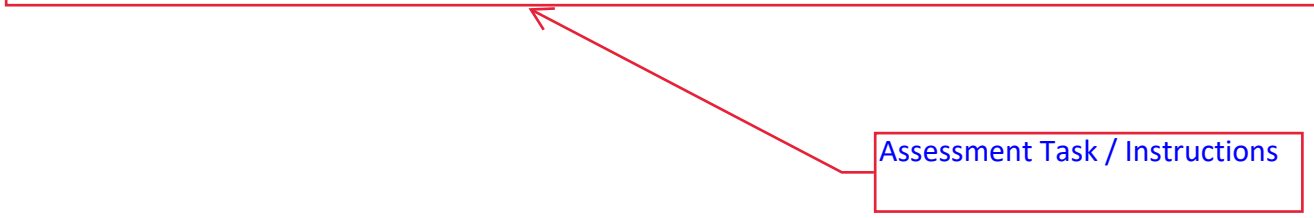
Grading is based on *correctness of the answer* (60%), *Logical and effective presentation of results* (25%), *Use of images and plots in reports* (5%) and *Writing skills* (10%).

(II) Instructions for Project Report

- Students are required to solve two sets of problems individually and produce two reports. Each set of problems and report is worth 10% of the assessment. These problems focus more on critical thinking, problem-solving skills, and the ability to present one's own findings.
- Some problems require students to run and compare different algorithms. They need to describe the advantages and disadvantages of each algorithm.
- Students are expected to run their code and present their findings using appropriate plots and descriptions in their reports.
- In addition to the assigned problems, the assessment provides a platform for students to think critically. They have the flexibility to experiment with different algorithms and comment on the strengths and weaknesses of each.

Grading criteria

Grading is based on *Scientific content* (60%), *Logical and effective presentation of results (25%), Use of images and plots in reports (5%) and Writing skills (10%).*



(III) Instructions for Presentation

After completing their individual projects, students are required to deliver two group presentations on their project results and problem-solving approaches. It will be a **10-minute oral presentation**, followed by a **2-minute Q&A session**. Each presentation is worth 10% of the total assessment.

- Each presentation should be delivered using PowerPoint slides, which should include relevant plots, explanations, and results using Python.
- The results should be presented using images and graphs generated by Python.

Grading criteria

Grading is based on *Scientific content* (40%), *Presentation Skill (30%), PowerPoint Organization (30%).*

Grading Rubrics

Clear descriptions of expectations of performance.

Written Assignment				
	Excellent	Good	Satisfactory	Unsatisfactory
Correctness of answer (60%) (digital literacy)	Concepts very clearly understood; high level of proficiency in using Python for simulation and data analysis; results are all accurate.	Concepts generally understood, good level of proficiency in using Python for simulation and data analysis; results are mostly accurate.	Some concepts are understood; fair level of proficiency in using Python for simulation and data analysis; results have minor errors.	Concepts poorly understood; poor level of proficiency in using Python for simulation and data analysis; inaccurate results.
Logical and effective presentation of scientific ideas (25%) (writing literacy)	Always make sound and logical arguments when presenting and interpreting the data in written format.	Most arguments are sound and logical when presenting and interpreting the data in written format.	Some arguments are sound and logical when presenting and interpreting the data in written format.	Most arguments are unsound or illogical when presenting and interpreting the data in written format.
Use of images and plots in reports (5%) (visual & digital literacy)	Accurate images and plots generated from Python, and these are used to clearly present information for supporting scientific	Generally correct images and plots generated from Python, and these are used to help present information for supporting scientific argument and conclusion.	Fair images and plots generated from Python, and some help present information for supporting scientific argument and conclusion.	Poor images and plots generated from Python, and they do not help present information for supporting scientific argument and conclusion.

Clear assessment criteria. These skills must be taught explicitly in the course.

	argument and conclusion.			
Writing (10%) (written literacy)	Always clear presentation of results; always use appropriate language, format, and accurate scientific terms; fluent, clear and concise writing.	Generally clear presentation of results; mostly use appropriate language, format, and accurate scientific terms; fluent, clear and concise writing.	Fair presentation of results; Some inappropriate use of language, format, or scientific terms; some grammatical errors or inappropriate vocabulary.	Poor presentation of results; Unacceptable use of language, format, or scientific terms; frequent grammatical errors or inappropriate vocabulary.

Clear assessment criteria. These skills must be taught explicitly in the course.

Clear descriptions of expectations of performance.

Project Report

	Excellent	Good	Satisfactory	Unsatisfactory
Scientific content (60%) (digital literacy)	Concepts very clearly understood; high level of proficiency in using Python for simulation and data analysis; results are all accurate.	Concepts generally understood, good level of proficiency in using Python for simulation and data analysis; results are mostly accurate.	Some concepts are understood; fair level of proficiency in using Python for simulation and data analysis; results have minor errors.	Concepts poorly understood; poor level of proficiency in using Python for simulation and data analysis; inaccurate results.
Logical and effective presentation of scientific ideas (25%) (written literacy)	Always make sound and logical arguments when presenting and interpreting the data in written format.	Most arguments are sound and logical when presenting and interpreting the data in written format.	Some arguments are sound and logical when presenting and interpreting the data in written format.	Most arguments are unsound or illogical when presenting and interpreting the data in written format.
Use of images and plots in reports (5%) (digital literacy)	Accurate images and plots generated from Python, and these are used to clearly present information for supporting scientific	Generally correct images and plots generated from Python, and these are used to help present information for supporting scientific argument and conclusion.	Fair images and plots generated from Python, and some help present information for supporting scientific argument and conclusion.	Poor images and plots generated from Python, and they do not help present information for supporting scientific argument and conclusion.

	argument and conclusion.			
Writing (10%) (written literacy)	Always clear presentation of results; always use appropriate language, format, and accurate scientific terms; fluent, clear and concise writing.	Generally clear presentation of results; mostly use appropriate language, format, and accurate scientific terms; fluent, clear and concise writing.	Fair presentation of results; Some inappropriate use of language, format, or scientific terms; some grammatical errors or inappropriate vocabulary.	Poor presentation of results; Unacceptable use of language, format, or scientific terms; frequent grammatical errors or inappropriate vocabulary.

Oral Presentation				
	Excellent	Good	Satisfactory	Unsatisfactory
Scientific content (40%) (digital literacy)	Concepts very clearly understood; high level of proficiency in using Python for data taking and analysis; results are all accurate.	Concepts generally understood, good level of proficiency in using Python for data taking and analysis; results are mostly accurate.	Some concepts are understood; fair level of proficiency in using Python for data taking and analysis; results have minor errors.	Concepts poorly understood; poor level of proficiency in using Python for data taking and analysis; inaccurate results.
Presentation Skill (30%). (oral literacy)	Always clear presentation of programming procedures and results; always use appropriate language, format, and accurate scientific terms; fluent, clear and concise oral presentation.	Generally clear presentation of programming procedures and results; mostly use appropriate language, format, and accurate scientific terms; fluent, clear and concise oral presentation.	Fair presentation of programming procedures and results; Some inappropriate use of language, format, or scientific terms; some grammatical errors or inappropriate vocabulary.	Poor presentation of programming procedures and results; Unacceptable use of language, format, or scientific terms; frequent grammatical errors or inappropriate vocabulary.

PowerPoint Organization (30%) (visual & digital literacy)	Accurate images and plots generated from Python, and these are used to clearly present information for supporting scientific argument and conclusion. The PowerPoint includes a clear introduction, a concise problem statement, a thorough explanation of the methodology and programming setup, a presentation of results with insightful analysis, a discussion of strengths and limitations, a succinct conclusion, and an allocated time for a Q&A session.	Generally correct images and plots generated from Python, and these are used to help present information for supporting scientific argument and conclusion. The PowerPoint include most of the parts including a concise problem statement, a thorough explanation of the methodology and programming setup, a presentation of results with insightful analysis, a discussion of strengths and limitations, a succinct conclusion, and an allocated time for a Q&A session.	Fair images and plots generated from Python, and some help present information for supporting scientific argument and conclusion. The PowerPoint include some of the parts including a concise problem statement, a thorough explanation of the methodology and programming setup, a presentation of results with insightful analysis, a discussion of strengths and limitations, a succinct conclusion, and an allocated time for a Q&A session.	Poor images and plots generated from Python, and they do not help present information for supporting scientific argument and conclusion. The PowerPoint include few parts including a concise problem statement, a thorough explanation of the methodology and programming setup, a presentation of results with insightful analysis, a discussion of strengths and limitations, a succinct conclusion, and an allocated time for a Q&A session.