**New York City College of Technology**

**Interdisciplinary Committee**

**Application for Interdisciplinary Course Designation**

**Date \_\_\_\_\_\_\_\_\_\_10/30/2017\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Submitted by** \_\_\_\_\_\_V. Acquaviva, A. Satyanarayana\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Department(s) \_\_**Physics, CST**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

1. **Proposal to Offer an Interdisciplinary Course**

1. Identify the course type and title:  
     
   🞎 An existing course\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
     
     A new course \_\_(The course was already in existence, but it is being offered for the first time).\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

🞎 A course under development \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Provide a course description \_\_\_\_\_\_\_

The course focuses on problem solving in Physics and Astronomy through statistical inference, machine learning algorithms and data mining techniques.

Students will be presented with data sets and research problems in different areas of physics and will solve them using tools such as Bayesian statistics, Monte Carlo sampling, regression and classification algorithms, dimensionality reduction, and data cleaning. The programming assignments will be carried out in current, flexible languages, such as Python. Students will become familiar with data sets and practical applications from different branches of physics, such as particle physics and astrophysics. For their final project, student will select their own data set, formulate a research question, and select their own tools to answer it. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. How many credits will the course comprise? \_\_3\_\_\_\_ How many hours? \_\_\_\_1 class hours and 3 laboratory hours\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What prerequisite(s) would students need to complete before registering for the course? Co-requisite(s)?

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| Students are required to have completed the CST 1201 or equivalent introductory programming course, as well as MAT 1372 or higher. |

1. Explain briefly why this is an interdisciplinary course. \_\_

This course is at the intersection of Physics and Computer Science. The advent of big data has produced a true revolution in how data analysis, hypothesis testing and parameter estimation are carried out in all branches of physics, from particle physics, to astrophysics, to condensed matter physics. Any physics graduate should be familiar with and used to applying the scientific method by means of these modern tools, which were previously considered to belong only in the toolset of a computer scientist. On the other hand, students in other STEM programs might enjoy also being exposed to rich and varied data sets from the physics world, and having the opportunity to work on authentic research problems.

1. What is the proposed theme of the course? What complex central problem or question will it address? What disciplinary methods will be evoked and applied?

The theme of the course is how to optimally extract information from complex data sets by utilizing statistical inference, machine learning and data mining techniques. These methods can be used for accurate parameter measurements, for predictive modeling in classification or regression problems, to group together elements with similar characteristics in data sets, and so on. They have applications in a number of disciplines, from physics to biology, chemistry and engineering, but also in other fields, such as finance and game theory. The process of learning will be very hands-on, with brief lectures complemented by in-class quizzes, programming assignments that will occasionally be peer-reviewed, longer-term programming homework, and a final project where students will have freedom to choose a problem and how to solve it.

1. Which general learning outcomes of an interdisciplinary course does this course address?   
   Please explain how the course will fulfill the bolded mandatory learning outcome below. In addition, select and explain at least three additional outcomes.

**Purposefully connect and integrate across-discipline knowledge and skills to solve problems**

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| The core concept of this course is to teach physics students how to think as computer scientists and how to utilize rigorous and modern methods to analyze their data, and to teach non-physicists how to deal with complex real-world physics problems in various sub-disciplines. |

**Synthesize and transfer knowledge across disciplinary boundaries**

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| Besides being exposed to cross-disciplinary problems for the whole duration of the course, students will work in teams and will have several chances to communicate with each other and transfer knowledge. The final project will require them to select a problem, synthesize their rational for picking this problem and a proposed solution, and finally present their findings. |

Comprehend factors inherent in complex problems

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| A key element of using machine learning and data mining algorithms is in selecting the most important variables. This is an art, more than a skill, which results from a careful analysis of the known properties of a system. |

Gain comfort with complexity and uncertainty

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| During this course, students will be analyzing data sets of increasing size and complexity, and they will learn how crucial is to quantify the uncertainty associated to any measurement or inferred property. They will reinforce their knowledge of probability and statistics and truly understand what “experimental or measurement errors” are and how they feature into results. |

Think critically, communicate effectively, and work collaboratively

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| Students will work in teams, will have to present their work to others, and will be solving open-ended problems for which the answer can’t be found in the proverbial back of the book. |

**General Education Learning Goals for City Tech Students**

* **Knowledge:** Develop knowledge from a range of disciplinary perspectives, and hone the ability to deepen and continue learning.
* **Skills:** Acquire and use the tools needed for communication, inquiry, creativity, analysis, and productive work.
* **Integration**: Work productively within and across disciplines.
* **Values, Ethics, and Relationships**: Understand and apply values, ethics, and diverse   
  perspectives in personal, professional, civic, and cultural/global domains.

1. How does this course address the general education learning goals for City Tech students?

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| This course will allow students to improve their knowledge in the disciplines of physics, computer science and mathematics, to hone their skills in every step of the research process, from formulating the questions to testing hypotheses to assessing uncertainties, and to work in teams and learn to welcome others’ ideas and test their own through peer assessment. |

1. Which department would house this course[[1]](#footnote-1)? \_\_\_The course will be hosted by the Physics department.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Would all sections of the course be interdisciplinary? 🞎 No  Yes
   1. Would the course be cross-listed in two or more departments?  No 🞎 Yes   
      Explain.

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| For the time being, this section will be listed in the Physics Department. This has the additional advantage of appealing to CST students who need to take an ID course outside their department. |

* 1. How will the course be team-taught[[2]](#footnote-2)?  Co-taught 🞎 Guest lecturers 🞎 Learning community

If co-taught, what is the proposed workload hour distribution?

The 60 credit hours will be divided as 45 hours: Physics, 15 hours: CST

Shared credits 🞎 Trading credits

If guest lecturers, for what approximate percentage of the course? 🞎 Minimum 20%[[3]](#footnote-3) 🞎 other: \_\_%

* 1. What strategies/resources would be implemented to facilitate students’ ability to make connections across the respective academic disciplines?

Please attach the evaluation framework used to assess the interdisciplinarity of the course.[[4]](#footnote-4)

Every weekly theme of lecture and laboratory work in PHYS3600ID is designed to promote learning goals of both disciplines. Students will be required to understand the variables and framework of Physics problems, through reading published Physics papers (accessible free of charge from the arXiv) that provide the foundation for each computational task and other notes. They will also, on a weekly basis, consult the programing and machine-learning manual that is available online and comprises tutorials and worked examples, in order to master the computer science component of the course.

Assignments and in-class practice will reflect the interdisciplinarity of the course in the following manners:

1) For their weekly or biweekly homework, students will be required to briefly summarize the problem that they are trying to solve numerically and synthesize insights and challenges from the Physics and Computer Science perspective.

2) In their weekly and long-term assignments, students will be asked to provide a working solution and, whenever this is not possible, to explain the methodology used and the roadblocks they encountered, and they will learn how to and be asked to visualize data in a meaningful manner. This skill can be applied to any of their chosen major.

3) Students will be required to do peer assessment of other students’ work, evaluating the clarity of the problem summary, the efficiency and correctness of the solution, and the programming style. Students will also assess the final presentation of other group according to a rubric developed by instructors.This will introduce them to the process of peer review that is a core component of liberal arts and sciences in all disciplines.

4) Through their final project and in-class presentation, students will learn how to work in teams that may include students coming from different disciplines. They will work on solving research problems independently and on presentation skills, which will benefit them independent of their academic discipline, and their evaluation rubric, which will be shared with them, will include components from both Physics and Computer Science.

1. Would the course be designated as:

🞎 a College Option requirement[[5]](#footnote-5)? 🞎 an elective? 🞎 a Capstone course[[6]](#footnote-6)?  other? Explain.

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| The course will be required for students in the Applied Computational Physics major and open to all other interested students as an elective. |

1. An interdisciplinary course for the College Option requirement may be housed in a department that is not liberal arts. [↑](#footnote-ref-1)
2. Attach evidence of consultation with all affected departments. [↑](#footnote-ref-2)
3. While an interdisciplinary course must be team-taught, there is no formal percentage requirement, but this minimum is a guideline. [↑](#footnote-ref-3)
4. In the case that a course is equally taught, include proposed plans for faculty classroom observation and student evaluation of teaching. [↑](#footnote-ref-4)
5. To qualify for the College Option, such a course must also meet the New York State definition of a liberal arts and sciences course.  
   <http://www.highered.nysed.gov/ocue/lrp/liberalarts.htm> [↑](#footnote-ref-5)
6. A course proposed as a Capstone course must be separately approved by the Capstone Experience Committee. [↑](#footnote-ref-6)