Fiscal Unit/Academic Org	Physics - D0684
Administering College/Academic Group	Arts and Sciences
Co-adminstering College/Academic Group	Arts and Sciences
Semester Conversion Designation	New Program/Plan
Proposed Program/Plan Name	Computational Physics Certificate
Type of Program/Plan	Undergraduate certificate program
Program/Plan Code Abbreviation	COMPPHY
Proposed Degree Title	

Credit Hour Explanation

Program credit hour requirements		A) Number of credit hours in current program (Quarter credit hours)	B) Calculated result for 2/3rds of current (Semester credit hours)	C) Number of credit hours required for proposed program (Semester credit hours)	D) Change in credit hours
Total minimum credit hours required for completion of program				13	
Required credit hours offered by the unit	Minimum			7	
	Maximum				
Required credit hours offered outside of the unit	Minimum			6	
	Maximum				
Required prerequisite credit hours not included above	Minimum			0	
	Maximum				

Program Learning Goals

Note: these are required for all undergraduate degree programs and majors now, and will be required for all graduate and professional degree programs in 2012. Nonetheless, all programs are encouraged to complete these now.

Program Learning Goals

- Upon completion of the academic certificate in Computational Physics, students will be better prepared to

(1) study physics datasets and theories to test scientific hypotheses using computational analyses.

- (2) apply systems-level thinking to addressing scientific questions.
- (3) continue in the field of physics in a graduate program or employed in the private sector well-prepared to adapt to the rapidly changing field of computational analysis.

Assessment

Assessment plan includes student learning goals, how those goals are evaluated, and how the information collected is used to improve student learning. An assessment plan is required for undergraduate majors and degrees. Graduate and professional degree programs are encouraged to complete this now, but will not be required to do so until 2012.

Is this a degree program (undergraduate, graduate, or professional) or major proposal? No

Program Specializations/Sub-Plans

If you do not specify a program specialization/sub-plan it will be assumed you are submitting this program for all program specializations/sub-plans.

Pre-Major

Does this Program have a Pre-Major? No

Attachments

- Certificate_Proposal_CompPhys.pdf

(Program Proposal. Owner: Thaler,Lindsey Nicole)

Comments

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Thaler,Lindsey Nicole	12/09/2022 12:44 PM	Submitted for Approval
Approved	Humanic,Thomas John	12/09/2022 01:05 PM	Unit Approval
Approved	Vankeerbergen,Bernadette Chantal	01/17/2023 02:54 PM	College Approval
Pending Approval	Cody,Emily Kathryn Jenkins,Mary Ellen Bigler Hanlin,Deborah Kay Hilty,Michael Vankeerbergen,Bernadette Chantal Steele,Rachel Lea	01/17/2023 02:54 PM	ASCCAO Approval

Proposal for an undergraduate embedded Certificate in Computational Physics

December 6, 2022

Proposal Submission Guidelines for Establishing a New Certificate

1. Required Information

- Name of proposed certificate. Identify certificate type from certificate grid (*e.g.*, Type 2, standalone post-bachelor undergraduate certificate).

  Computational Physics, type 1b (undergraduate academic certificate, embedded)

- Indicate whether the certificate will be delivered wholly on-line, wholly in-person, a combination, or with all hybrid courses.

  In-person delivery.

- Proposed implementation date.

  Autumn 2023

- Academic units (e.g., department, college) responsible for administering the certificate program.

  Physics, Arts and Sciences

2. Rationale

- Describe the rationale/purpose of the certificate.

  Many students majoring in Physics, Engineering Physics and Astronomy arrive at Ohio State with an interest in computers and software development. Computation is an integral part of modern science and the certificate in computational physics is designed to educate students in computer simulation of physical systems. Computational physics prepares students to build computational models, design algorithms for numerical solutions, analyze the calculated data and perform computer experiments, (that are otherwise unfeasible), by using high-performance computers. A certificate in computational physics proves that students are skilled in modeling physical systems and delivering solutions through computer programming.

  A good example of the interest of employers in computational physics is found with the Office of Science of the U. S. Department of Energy (DOE). The DOE supports over 40 percent of the basic research in physical sciences in the United States and operates 10 major laboratories, such as the Argonne National Laboratory, Princeton Plasma Physics

Laboratory, and SLAC National Accelerator Laboratory. Its Advanced Scientific Computing Research (ASCR) program promotes careers in computational physics and the use of tools to analyze, model, simulate, and predict complex phenomena important to the DOE. In 2001, it began the Scientific Discovery through Advanced Computing (SciDAC) program that supports many computational physics jobs. The program is focused on advancing scientific discovery using supercomputers performing trillions of calculations per second (tera-scale). SciDAC projects are aimed at "developing future energy sources, studying global climate change, accelerating research in designing new materials, improving environmental cleanup methods, and understanding physics from the tiniest particles to massive supernovae explosions." SciDAC publishes a journal and has established SciDAC Institutes at four major universities with a total of 13 universities participating in the partnership.

Ohio State has significant strength in computing, but no well-defined program in computational physics. This certificate will clarify to students, grad schools, and employers that the student was engaged in a coherent set of undergraduate coursework to prepare the student to pursue computational physics as a career or to use it in graduate school.

- Identify a likely source of student demand for the proposed certificate, and provide one or two examples.

  Students majoring in these programs will be able to indicate their focus on computational physics with such a certificate with a minimum of extra courses.

  For example, a student majoring in Physics, Engineering Physics or Astronomy will be able to complete the certificate with 2 additional courses with strategic choices within the major.

- Provide the following statement: *Upon completion of the academic certificate in* <specify title>*, learners will be better prepared to. . .*" <list a maximum of 3 outcomes>.

  Upon completion of the academic certificate in Computational Physics, students will be better prepared to

  (1) study physics datasets and theories to test scientific hypotheses using computational analyses.
  (2) apply systems-level thinking to addressing scientific questions.
  (3) continue in the field of physics in a graduate program or employed in the private sector well-prepared to adapt to the rapidly changing field of computational analysis.

  These learning objectives will be reflected in the assignments and the projects in all of the selected courses.

Assessment of the objectives of the certificate program will be carried out using direct and indirect measurements. In particular, the following data will be collected and analyzed to improve the quality of the program:

- *Cumulative students' GPAs.*
- *Average GPA of certificate students taking a course compared with the average GPA of all students taking the same course.*
- *Number of applications for the program*
- *Quality of the acceptant pool (GPA and diversity).*
- *Acceptance rate.*
- *Completion rate.*
- *Time-to-certificate*
- *Exit survey at program completion.*
- *Follow-up studies of the success of students receiving the certificate in obtaining computational physics jobs or entering graduate programs.*

3. Relationship to Other Programs / Benchmarking

- Identify any overlaps with other programs or departments within the university. Append letters of concurrence or objection from related units.

  The certificate overlaps with the BS in Physics and the BS in Engineering Physics, both of which are administered by the Department of Physics.

  Concurrence for this program has been obtained from the Department of Electrical and Computer Engineering (ECE).

- Indicate whether this certificate or a similar certificate was submitted for approval previously.

  This is a new proposal. No such certificate proposal has been submitted for approval previously.

  Explain at what stage and why that proposal was not approved or was withdrawn.

  N/A

- Identify similar programs at other universities in Ohio or in the United States and their levels of success.

  There are no similar programs in Ohio.

  There are several undergraduate certificate programs in computational science that specialize in physics, two examples being at the University of Illinois at Urbana-Champaign offered by the College of Engineering https://cse.illinois.edu/cse-educational-programs/undergraduate-certificate/ , and at the University of Missouri offered by the College of Arts and Science,

http://catalog.missouri.edu/collegeofartsandscience/additionalcertificatesminors/cert-computational-physics/ . The certificate programs offered by these universities are similar in scope with the certificate program being proposed here.

4. Student Enrollment

- Indicate the number of students you anticipate will choose to pursue this certificate.

  Based on a recent survey of our current majors, we anticipate initial enrollment to be modest, about 20-40. Growth will be facilitated with outreach to the relevant populations in Physics, Engineering Physics, Astronomy and ECE. The Undergraduate Studies Committee in Physics will advertise the certificate during student visit days, communicate the opportunity to advisors and the career center

  .

5. Curricular Requirements

- Provide ASC certificate advising sheet.

  See Appendix A

- List the courses (department, title, credit hours, description) which constitute the requirements and other components of the certificate. If any courses have prerequisites, please indicate so. Indicate which courses are currently offered and which will be new. When new course requests are submitted through curriculum.osu.edu, indicate that those course requests are being submitted as part of a new certificate proposal. As much as possible, the curriculum committees will review the course requests in conjunction with the certificate proposal.

  Each student completing the certificate will be required to take two courses offered by the Department of Physics in computational physics, and two elective courses from the list given in the tables below. Students will be able to overlap their curriculum by 50%, as permitted by the rules of the certificate. ***All courses listed are currently offered.***

Required courses – All students must take the two courses listed below.

Course number	Course Name	Credit hours	Prerequisites
Physics 5680	Big Data Analytics in Physics *Provides an introduction to machine learning and advanced algorithms, with an emphasis on practical physics-based applications, using publicly available data sets. The goal is to provide an introduction to Data Science for students who may want*	3	Enrollment in the Physics, Astronomy or Engineering Physics major; C- or higher in CSE 1222, CSE 1223, Engineering 1281H, or Astronomy 1221; C+ or higher in Physics 1251,

	to pursue this as a career option and/or apply these techniques in a research environment.		or instructor permission.
Physics 5810 Course number change request from 6810 to 5810 submitted	Topics in Computational Physics *Experimental and theoretical aspects of areas of current interest in computational physics.*	4	CSE 1222, CSE 1223, CSE 1224, Astronomy 1221, Engineering 1221, or Engineering 1281H; and Physics 5500, or instructor permission

Elective courses – Students must take two courses from the list below.

Course number	Course Name	Credit hours	Prerequisites
CBE 5780	Molecular Dynamics Simulations *Students learn to use standard open-source software to carry out molecular dynamics simulations on a supercomputer.*	3	Junior standing or above in Physics or Engineering Physics
Math 3607	Beginning Scientific Computing *Introduction to mathematical theory of algorithms used to solve problems that typically arise in sciences, engineering, and finance.*	3	C- or better in Math 2255 and Math 2568 or equivalents
CSE 5361	Numerical Methods *Numerical methods for scientific computation: computer arithmetic, rounding errors, machine precision, machine representation, root-finding, interpolation, integration, linear systems, splines, smoothing, curve-fitting, linear programming*	3	Math 2231, and Math 2568 (268) or 571, and Math 1151
STAT 3201	Introduction to Probability for Data Analytics *An introduction to probability and its role in statistical methods for data analytics. Equal emphasis is placed on analytical and simulation-based methods for quantifying uncertainty. Approaches to assessing the accuracy of simulation methods are discussed. Applications of*	3	Math 1152, 1161.xx, 1172, 1181, or equiv; or permission of instructor.

	probability and sampling to big-data settings are discussed.		
ECE 5510	Introduction to Computational Electromagnetics *Numerical methods for solving maxwell equations both static and electrodynamics, introduction to finite difference, finite element and integral equation methods, and applied linear algebra.*	3	ECE 3010, Physics 5400, or permission by instructor
Math 5601	Essentials of Numerical Methods *Systems of linear equations, linear least squares, eigenvalue problems, nonlinear equations and optimization, interpolation, numerical integration and differentiation, numerical solution for ODEs, IVPs and BVPs.*	3	4556 (556) and either 2568 (568) or 572, or permission by instructor

- State the minimum number of credits required for completion of the certificate.

  Total 13 hours
  .
- Indicate the number of semesters expected to complete the certificate. Confirm that courses are offered frequently enough and have the capacity to meet this expectation.

  4 semesters, Note that there is sufficient frequency of courses so that there is at least one course a student may take each semester. Every course is offered at least on alternate years. The courses have the capacity to meet the enrollment expectation.

- If applicable, describe existing facilities, equipment, and off-campus field experience and clinical sites to be used. Indicate how the use of these facilities, equipment, etc., will impact other existing programs.

  Resources from the Ohio Supercomputer Center will be used in several of the courses that are offered for the certificate.

- For interdisciplinary certificates, describe the way in which advising and other student support will be provided.

  N/A.

- If applicable, describe additional university resources (including advisors and libraries) that will be required for the new certificate.

  Advising and students support services are available through the department, college, and university, as is available to any student pursuing a program. In Physics, L. Thaler and D. Zach provide undergraduate student advising.

- Provide ASC completion sheet for certificates.

  See Appendix B

- Provide semester-by-semester sample program.

  Year 1:
  Math 3607 (Autumn) or Physics 5680 (Autumn)
  Physics 5810 (Spring) or CSE 5361 (Spring)
  Year 2:
  Physics 5680 (Autumn) or CBE 5780 (Autumn)
  CSE 5361 (Spring) or Physics 5810 (Spring)

Appendices

Appendix A: Advising Sheet

The Ohio State University
College of Arts and Sciences

Computational Physics Certificate, Type 1b

Advising Contact:
Ms. Lindsey Thaler
Director of Undergraduate Studies
Academic Advisor for Physics and Engineering Physics
Office: 1142 Physics Research Building
Email: thaler.21@osu.edu

Mr. David Zach
Academic Advisor for Physics and Astronomy
Offices: 1140 Physics Research Building (MThF); 4012 McPherson Lab (TuW)
Email: zach.11@osu.edu
Phone: 614-292-1358

Faculty Contact:
Dr. Thomas Humanic
Vice Chair for Undergraduate Studies
Office: 2144 Physics Research Building
Email: humanic.1@osu.edu
Phone: (614) 247-8950

The Computational Physics certificate will clarify to students, grad schools, and employers that the student was engaged in a coherent set of undergraduate coursework to prepare the student to pursue computational physics as a career or to use it in graduate school.

The Computational Physics certificate requires a minimum of 13 credits drawn from Physics and other departments and distributed as follows:

Take all of the following Physics courses:

Physics 5680: Big Data Analytics in Physics (3 credits)

Physics 5810: Topics in Computational Physics (4 credits)

Students will take two courses in other departments from the following list:

CBE 5780: Molecular Dynamics Simulations (3 credits)

Math 3607: Beginning Scientific Computing (3 credits)

CSE 5361: Numerical Methods (3 credits)

STAT 3201: Introduction to Probability for Data Analytics (3 credits)

ECE 5510: Introduction to Computational Electromagnetics (3 credits)

Math 5601: Essentials of Numerical Methods (3 credits)

Computational Physics Certificate Program Guidelines

Credit hours required: A minimum of 13.

Overlap with degree program: A student is permitted to overlap up to 50% of credit hours between other degree program (major, minor, other certificate, or general education) and the certificate program.

Grades required
• Minimum C- for a course to be counted on the certificate
• Minimum 2.00 cumulative GPA for all certificate course work.

Certificate approval: The certificate may be approved by the student's assigned academic advisor via the Degree Audit Report (DAR). If the certificate is not complete on the DAR, the student must consult with a College of Arts and Sciences advisor.

Filing the certificate program form: The certificate form must be filed at least by the time the graduation application is submitted to a college/school advisor.

Appendix B: Certificate Completion Sheet

College of Arts and Sciences

Computational Physics Certificate Program

Student name: _____

Student OSU Email: _____

Certificate Advisor Name: _____

Required Courses (7 credits):

Course (Hours)	**Course Grade**	**Term Completed**
Physics 5680: Big Data Analytics in Physics (3 credits)		
Physics 5810: Topics in Computational Physics (4 credits)		

Elective course -- Students must take two courses from this list (6 credits):

Course (Hours)	**Course Grade**	**Term Completed**
CBE 5780: Molecular Dynamics Simulations (3 credits)		
Math 3607: Beginning Scientific Computing (3 credits)		
CSE 5361: Numerical Methods (3 credits)		
STAT 3201: Introduction to Probability for Data Analytics (3 credits)		
ECE 5510: Introduction to Computational Electromagnetics (3 credits)		
Math 5601: Essentials of Numerical Methods (3 credits)		

Total credits (13): _____

Certificate Advisor Signature: _____

Date: _____