

Date: May 23, 2008

Subject: Proposed Revision to the Major in Physics

From: Mike Vasey, Chair, Subcommittee C

Subcommittee C considered the proposal for revisions to the Physics major on 4/30/08.

This revision proposes a single change to the requirements for a major in physics: All students must complete Computer Science and Engineering 202, Introduction to Programming and Algorithms for Engineers and Scientists. The proposal states that the addition of this 4 credit hour course is needed to meet the increased needs of students for exposure to sophisticated mathematical computing tools. This exposure is justified both because facility with such programs is required in advanced physics courses and in careers pursued by many graduates with a major in physics. A student survey provided clear support for additional preparation in the use of scientific software and programming tools, which students rated as very poor in the current major. Because some 70% of physics majors already take CSE 202, the impact on students in the major is limited. Furthermore, it is clear that despite the increase of 4-credits, it remains possible for students to complete the major and graduate with a minimum of 181 credit hours.

The consensus of the committee was that the proposed change to the requirements for the Physics major was clearly articulated and well-justified. The only question raised by the committee was whether the Department of Computer Science and Engineering would be able to handle the increased demand for CSE 202. However, a memo from Professor Bruce Weide, Associate Chair of the CSE department made it clear that CSE is prepared to meet this increased demand. It was noted that because some 70% of physics majors already take this course, the increase in demand would not be large. The subcommittee therefore voted unanimously in favor of the proposal.

Transmittal History for Revision to Physics Major

ASC CCI- Pending

5-31-08

CCI Sub-Committee C – Approved with all associated course change requests

4-30-08

7. Physics major revision

- i. Discussion of the main changes—credit hour increase, adding computing course requirement, changing pre-regs to courses
- ii. In proposal p.3 last paragraph, Bruce Weide is the “Associate Chair”, not Chair

MAPS CCC- Approved Unanimously with Contingencies

4-21-08

1. Physics Major revision and associated courses (416, 555, 621, 631)

- a. Intro by Richard of the proposal
- b. waiting for concurrence from Astronomy (received by Curriculum Office on 4/25)
- c. Justification for adding computing courses and changing pre-reqs: (1) it is the need of the field, (2) to allow later courses to focus on the content rather than students’ computing struggles. Other 9 bench mark institutions also make the same requirements-- a good reference for the change.
- d. Discussion on the relationship btw CIS202, Physics 350, 416, 517, 616, 780 and how the changes will affect different student groups, including Astronomy majors, transfers, and students from regional campuses. Richard will discuss this change with Astronomy more. Astronomy majors can wave the pre-reqs. Instructors can take care of individual students’ needs (in terms of computing skills needed for the class) when the majority of the class is prepared (because of the proposed pre-req change).
- e. CIS concurred with the change (rec’d 4/21) and expressed that they are able to accommodate the expected increasing needs of CIS 202.

Proposed Changes to the Physics Major program

Date: April 14th, 2008

Prepared by: Richard E. Hughes, Vice Chair for Undergraduate Studies, Physics;
Dr. Sandy Doty, Director of Undergraduate Studies, Physics

Background/Motivation

The Physics Undergraduate Studies Committee has discussed the addition of computing to the curriculum for at least 10 years. There have been persistent efforts of the part of physics instructors to add computing based tools such as MATLAB and Mathematica to the upper division courses Physics 555, Physics 631, and Physics 621. These efforts have been hampered by the lack of familiarity incoming students have with true computing tools (beyond something like Excel).

In addition, organizations like the American Institute for Physics (AIP) have noted the importance of computing both for Physics bachelors degree students, as well as those intending to pursue a physics PhD. In particular, they find:

- 1) 24% of Physics Bachelors have a job in software 5-8 years after graduation.
- 2) Students rated their preparation in Scientific Software and Scientific programming very poorly, while rating their importance to their current job as very high.
- 3) 75% of PhD recipients rated “Software Development or Modeling” as skills necessary “Some or Most of the Time”.

Clearly, computing skills are a necessary, yet overlooked, part of the undergraduate Physics major. See <http://www.aip.org/statistics/trends/reports/bachplus5.pdf> for more details on this topic.

Other Universities:

We have examined the computing requirements for Physics majors among our nine benchmark institutions. The results of this study fall into 4 basic categories:

- 1) A formal requirement for all majors:
Penn State University, the University of Arizona, the University of Illinois, and the University of Minnesota, all require a computing course as part of their undergraduate Physics Major curriculum.
- 2) A formal requirement for a subset of majors:
The University of Texas requires a computing course in 3 of their 6 options for a B.S. in Physics. The University of Washington Seattle has a technical elective requirement in which computing is 1 of 6 choices from which 2 must be chosen.
- 3) Encouragement, but no formal requirement:
The University of Wisconsin at Madison strongly encourages their physics majors to take a computing course, but there is no formal requirement to do so.
- 4) No requirement:
Among our 9 benchmark institutions, only the University of Michigan and UCLA have no computing requirement in their Physics Major curriculum.

The majority of our benchmark institutions have recognized the importance that computing skills play in the educational experience of their undergraduate physics majors.

Summary of Changes

The changes fall into two categories: the addition of a new prerequisite, and modification of prerequisites for courses that students are already required to take.

The new prerequisite will be for Physics 416: CSE 202, Introduction to Programming and Algorithms for Engineers and Scientists. This is a 4 credit hour course which has a single prerequisite of Math 151. Math 151 is already required for our majors, and all of our incoming students should be able to take CSE 202 in their first year, or in the first two quarters of their second year. Alternate courses offered by CSE would be considered as substitutes subject to approval by the Physics Undergraduate Studies Committee or their designee.

The modification of prerequisites essentially requires that Physics 416 be taken prior to Physics 555, 621, and 631 – which is typically the case for most of our majors already.

The summary of all of these prerequisite changes are as follows:

- 1) Physics 416: Add CSE 202 to the current prerequisite of Physics 133
- 2) Physics 555 (Fields and Waves I): Add Physics 416 to current prerequisites of Physics 261, Math 415 and Math 513
- 3) Physics 631 (Introductory Quantum Mechanics I): Add Physics 416 to current prerequisites of Physics 263, Math 415 and Math 568
- 4) Physics 621 (Statistical Physics I): Add Physics 416 to current prerequisites of Physics 263, Math 254 or Math 263

The primary motivations for these changes is twofold:

- 1) Physics 416 teaches experimental techniques of physics and the statistical analysis of data to students. To do this effectively requires the use of some programming. Since there is no computing requirement for this course presently, the instructor provides some simple programming instruction. However, since the programming skills of students varies greatly, the course instructor is usually forced to spend significant time training students in this important skill. A formal programming class prior to this course will allow the instructor to focus on the core aspects of data analysis which Physics 416 is intended to deliver.
- 2) The upper division courses of Physics 555, Physics 631, and Physics 621 are taken in the 3rd and/or 4th year by the overwhelming majority of our students. By adding Physics 416 as a requirement for these courses, this effectively requires students to take Physics 416 by the end of their second year, which is when Physics 416 was originally intended for students in the first place. Since computing will still be used in Physics 416, this ordering, plus the requirement of CSE 202, will give each student two formal programming experiences by the end of their second year. This will enable instructors of the upper division courses to integrate complex computer programming examples into their curriculum, without having to spend valuable time teaching programming techniques as well.

Impact of the Changes

Looking at graduates of the ASC Physics Major program for the years 2006 through 2007, which includes approximately 70 students, we determined that approximately 70% had taken CSE 202 or an equivalent course. As a result, the addition of CSE 202 as a required course would on average impact approximately 30% of our ASC physics majors.

The ASC Physics Majors choose among 6 different options when planning their major program: A:Advanced, B:General Sciences, C:Biophysics, D:Pre-med, E:Secondary Education, and F:Personalized. The total minimum number of hours to graduation remains at 181 credit hours for our students, even with this change. A sample curriculum for the Advanced Physics Major option A is attached as an appendix to this document.

Finally, an important result of both the CSE 202 requirement, as well as the prerequisite modifications, will be the impact on student readiness for research. If the proposed changes are approved, ALL of our ASC Physics majors will have two significant classroom computing experiences prior to the summer of their second year. Conversations with many faculty in the Physics department indicate that students who are already prepared with computing skills are at a significant advantage when they seek research employment with physics faculty. Research experience is a significant contributor to any physics student's success, whether they intend to seek employment immediately after graduation, or if they intend to go on to graduate work in physics. These changes will make students more attractive candidates for research positions.

Process/Recommendation

The changes were discussed in a series of Physics undergraduate studies meetings, through the spring and fall of 2007. The committee formally voted on the changes on January 8th, 2008, and unanimously approved them. A presentation of the proposed changes was made to the full faculty on January 24th, 2008, and approved at that meeting as well.

The changes were also discussed extensively with a broad collection of undergraduates at a Society of Physics Students (SPS) meeting on September 25th, 2007. The purpose of this meeting was to discuss the possible computing requirement as well as solicit student comments. The response was overwhelmingly favorable. In addition, a smaller meeting involving just the leadership officers of both SPS and Sigma Pi Sigma (the national honor society of Physics students) was held to discuss the changes. This group of 6 students was also very supportive of these changes. Finally, we should note that there are 3 student representatives on the Undergraduate Studies committee (only one of whom is in the previously mentioned leadership group), and they expressed strong support for these changes as well.

This addition of CSE 202 as a requirement has been discussed with the Chair of CSE, Prof Bruce Weide, and he has indicated that the additional students should not pose any problem from a staffing perspective. A copy of the letter of concurrence from CSE is attached to this proposal.

Associate

SAMPLE FOUR-YEAR PROGRAM

Bachelors of Science – Physics – Option A

The Physics Department offers 6 options to complete a Bachelors of Science in Physics. Option A is the program designed for those interested in pursuing graduate study in Physics. All other options require less Physics but may have specific other technical electives. Please consult the on-line handbook for details.

YR	AUTUMN	WINTER	SPRING
1	MATH 151 (5 hrs) Calculus and Analytical Geometry I PHYS 131 (5hrs) Intro. Physics; Particles and Motion GEC	MATH 152 (5 hrs) Calculus and Analytical Geometry II PHYS 132 (5hrs) Intro. Physics; Elec. and Magnetism GEC	MATH 153 (5 hrs) Calculus and Analytical Geometry III PHYS 133 (5hrs) Intro. Physics; Waves and Quantum CSE 202 (Proposed)
2	MATH 254 (5 hrs) Calculus and Analytical Geometry IV PHYS 261 (4 hrs) Dynamics of Particles and Waves, I PHYS 295 (1 hr) Undergraduate Seminar GEC	MATH 415 (4 hrs) Ordinary and Partial Differential Equations PHYS 262 (4 hrs) Dynamics of Particles and Waves, II GEC GEC	MATH 568 (3 hrs) Introductory Linear Algebra PHYS 263 (4 hrs) Dynamics of Particles and Waves, III PHYS 416 (4 hrs) Meth. Of Exper. Phys GEC
3	PHYS 555 (4 hrs) Fields and Waves I PHYS 631 (4 hrs) Intro. to Quantum Mechanics I MATH 513 (3 hrs) Vector Analysis GEC	PHYS 656 (4 hrs) Fields and Waves II PHYS 632 (4 hrs) Intro. to Quantum Mechanics II GEC	PHYS 657 (4 hrs) Fields and Waves III PHYS 633 (4 hrs) Intro. to Quantum Mechanics III PHYS 517 (4 hrs) Intro. Electronics GEC
4	PHYS 621 (4 hrs) Statistical Physics I PHYS 596 (3 hrs) Senior Seminar, Writing and Speaking GEC	PHYS 622 (4 hrs) Statistical Physics II PHYS 616 (4 hrs) Advanced Physics Lab GEC	PHYS 664 (4 hrs) Theoretical Mechanics GEC GEC

*A minimum of 191 total hours is required for graduation in the College of Arts and Sciences. The sample program above illustrates the physics and math courses. The remaining hours are comprised of courses chosen to complete the General Education Curriculum (GEC) of the College. The number of hours in the core program, GEC, and remaining free electives are indicated below the sample curriculum.

COURSES IN RED ONLY OFFERED ONCE PER YEAR

Credit Hrs in Core Courses	113
Credit Hrs in GEC	65
Free Electives	3
Total Hours in Program	181

CSE concurrence for Physics Major revision courses change

Hi Sophia

Here is the email of concurrence from Bruce Weide regarding adding CSE 202 to the Physics prereqs.

Richard

----- Forwarded message -----
Date: Fri, 14 Dec 2007 08:54:46 -0500
From: Bruce W. Weide <weide@cse.ohio-state.edu>
To: Sandy Doty <dotys@pacific.mps.ohio-state.edu>
Cc: Richard Hughes <hughes@mps.ohio-state.edu>,
Subject: Re: Letter of concurrence

Hi Sandy,

On 12/13/07 4:12 PM, "Sandra Doty" <dotys@pacific.mps.ohio-state.edu> wrote:
> Hi Bruce,
>
> It was good to meet with you Tuesday. Thank you for the information about > CSE 294P:
Computational Thinking in Context. Richard and I have discussed > this as a viable option for
the computing requirement he is planning to > implement for Physics majors starting in AU08.
>
> As we had discussed, due to a number of factors, Dr. Hughes is interested > in implementing
a computing requirement for all majors. After much > consideration, it seems reasonable that
CSE 202: Introduction to > Programming and Algorithms for Engineers and Scientists or an
equivalent > course, such as the pilot course CSE 294P; would fulfill that > need.
>
> Based on past scheduling behavior of our majors, a significant number of > whom already
take CSE 202 or an equivalent, we project that introducing > this requirement would result in
approximately 20 more physics students > taking this course each year.
>
> I am writing to confirm with you that this change in our curriculum is > acceptable to you and
that you feel CSE can handle the increased load.
>
> Please let me know if this is indeed acceptable OR if you have any > questions/ concerns.
>
> Sincerely,
>
> Sandy

To confirm, yes, CSE will be able to handle these students in CSE 202 and/or CSE 294P. We
look forward to the opportunity to work with you and to help however we can in this important
initiative.

--
Cheers,
-Bruce

Bruce W. Weide
Professor and Associate Chair
Dept. of Computer Science and Engineering The Ohio State University
2015 Neil Ave.
Columbus, OH 43210-1277

Concurrence from Astronomy for Physics Major Revision

From: dmterndrup@gmail.com; on behalf of; Don Terndrup [terndrup@astronomy.ohio-state.edu]
Sent: Fri 4/25/2008 6:27 PM
Subject: Re: concurrence request for Physics Major revision

Hi --

We concur with the proposed major changes in Physics. If there is anything else to do other than sending this email, please let me know.

Don Terndrup

On Fri, Apr 25, 2008 at 4:32 PM, Sophia Lee <lee.1307@osu.edu> wrote:

>
> Hi Don,
>
> Would you please let us know if Astronomy concurs with Physics Major
> revision proposal? Your concurrence is the last contingency for it to
> be approved at the college level. The proposal can be reviewed at:
> <http://artsandsciences.osu.edu/currofc/tracking.cfm?TrackingID=1223>
>
> Please let us know by 4/30 (wed) if possible. If you need more time,
> please also feel free to let us know. Thank you very much and have a good weekend.
>
> Sophia
>
> Sophia Lee, Ph.D.
>
> Program Coordinator, Curriculum and Assessment Office
>
> Colleges of Arts and Sciences
>
> The Ohio State University
>
> Phone (614) 688-5679
>
> Fax (614) 688-5678
>
> E-mail: lee.1307@osu.edu
>