May 7, 2014

MEMORANDUM

TO: Jayanth Banavar  
   Dean, College of Computer, Mathematical, & Natural Sciences

FROM: Elizabeth Beise  
       Associate Provost for Academic Planning and Programs

SUBJECT: Proposal to Modify the Bachelor of Science in Physics (PCC log no. 13061)

At its meeting on May 2, 2014, the Senate Committee on Programs, Curricula, and Courses approved your proposal to modify the Bachelor of Science in Physics. A copy of the approved proposal is attached.

The change is effective Fall 2014. Please ensure that the change is fully described in the Undergraduate Catalog and in all relevant descriptive materials, including the undergraduate program’s four-year plan (contact Lisa Kiely at lkiely@umd.edu for more information).

MDC/

Enclosure

cc: Marilee Lindemann, Chair, Senate PCC Committee  
    Barbara Gill, Office of Student Financial Aid  
    Reka Montfort, University Senate  
    Erin Howard, Division of Information Technology  
    Pam Phillips, Institutional Research, Planning & Assessment  
    Anne Turkos, University Archives  
    Linda Yokoi, Office of the Registrar  
    Doug Roberts, Undergraduate Studies  
    Drew Baden, Department of Physics
College/School:
Please also add College/School Unit Code-First 8 digits: 01203000
Unit Codes can be found at: https://hpprod.umd.edu/Html_Reports/units.htm

Department/Program:
Please also add Department/Program Unit Code-Last 7 digits: 1302301

Type of Action (choose one):
☐ Curriculum change (including informal specializations)
☐ Curriculum change for an LEP Program
☐ Renaming of program or formal Area of Concentration
☐ Addition/deletion of formal Area of Concentration
☐ Suspend/delete program

Italics indicate that the proposed program action must be presented to the full University Senate for consideration.

Summary of Proposed Action:
In summary, the Department of Physics is overhauling its principal undergraduate program in a major way for the first time in since the mid 1990s. While the formal changes to the program are relatively modest, they are designed to make the program significantly more effective.

The main reason for making the changes is to enhance the physics major by a) having the level of difficulty rise more smoothly as students go through the program to avoid difficulties in the higher level classes; b) ensuring that the mathematics the students study articulate well with the physics; c) ensure that students have some experience with computational physics—a subject of importance in both academic and industrial science; d) give students significantly more exposure to subjects of current interest in the field.

We also propose to remove the “Professional Area of Concentration” reference from the name of this major and call it simply, The Physics Major. We will continue to offer an area of concentration in secondary education.

Departmental/Unit Contact Person for Proposal: Tom Cohen
To: Robert Infantino  
   Associate Dean  
   College of Computer, Mathematical and Natural Sciences

From: Thomas Cohen  
   Associate Chair for Undergraduate Education  
   Department of Physics

Re: Changes to the Physics B.S. Professional Area of Concentration

Date: 04-04-2014 (revision)

Please find attached a draft of a proposal to the PCC committee to change the requirements to get a B.S. in  
Physics - Professional Area of Concentration (19020).

In summary, the Department of Physics is overhauling its principal undergraduate program in a major way for  
the first time in since the mid 1990s. While the formal changes to the program are relatively modest, they are  
designed to make the program significantly more effective.

The main reason for making the changes is to enhance the physics major by a) having the level of difficulty rise  
more smoothly as students go through the program to avoid difficulties in the higher level classes; b) ensuring  
that the mathematics the students study articulate well with the physics; c) ensure that students have some  
experience with computational physics—a subject of importance in both academic and industrial science; d)  
give students significantly more exposure to subjects of current interest in the field.

For the Physics Department, the main benefits of the changes are to ensure that our students get the type of  
education necessary to meet the challenges of the twenty-first century.

This proposal was prepared by implementation committee composed of Professors Einstein, Girvan and  
Chacko and Associate Chair Cohen (ex Officb) along with staff member Tom Gleason. This work was the  
outgrowth of a curriculum reform committee chaired by Professors Appelbaum and Bedaque and consisting  
of Professors Anlage, Cohen, Girvan, Losert, Rolston and Shawhan. This committee’s report was discussed  
by the Physics Faculty in our annual retreat. The committee did significant research into best practices when  
recommending these changes.

Note that this proposal does not suggest any changes to the Physics - Secondary Education Area of  
Concentration (1902E). While changes to the Professional Area of Concentration will necessitate one minor  
course substitution, i.e., substituting PHYS373 for the PHYS374 requirement, this will not substantively  
change the Secondary Education Area of Concentration. Furthermore with the probable implementation of  
UTEach for STEM Secondary Education Certification programs on campus, we expect to review our  
Secondary Education Area of Concentration in the near future.
Information Required in Curriculum Change Proposals

1. Current (old) requirements. As shown in the catalog, plus additional materials, if any, prepared by the Department or College and distributed to current students.

The following are the current (old) requirements for getting a B.S. in Physics - Professional Area of Concentration.

The required courses for a major in Physics - Professional Area of Concentration consist of an introductory sequence of three lecture courses and three laboratory courses, an upper level requirement of three physics courses, a supporting set of five required mathematics courses, a set of four approved upper level courses in a Professional Focus area, and supporting courses, in addition to any Core, Gen Ed or University-wide distribution requirements.

The required introductory 14-credit sequence is:

PHYS 171 (3): Introductory Physics: Mechanics and Relativity
PHYS 174 (1): Physics Lab Introduction
PHYS 272 (3): Fields
PHYS 275 (2): Experimental Physics I: Mechanics, Heat, and Fields
PHYS 273 (3): Waves
PHYS 276 (2): Experimental Physics II: Electricity and Magnetism

The 18-19 credit supporting mathematics courses that must be taken in parallel with the above courses (per their prerequisites) are:

MATH 140 (4): Calculus I
MATH 141 (4): Calculus II
MATH 240 (4): Introduction to Linear Algebra or MATH 461 (3): Linear Algebra for Scientists and Engineers
MATH 241 (4): Calculus III
MATH 246 (3): Differential Equations for Scientists and Engineers

Professional Physics Area of Concentration - Upper Level Requirements
For the Professional Physics area of concentration, a student must also complete the following upper level courses in the Professional Focus area, totaling 16 credits:

PHYS 401 (4): Quantum Physics I
PHYS 402 (4): Quantum Physics II
PHYS 410 (4): Classical Mechanics
PHYS 411 (4): Intermediate Electricity and Magnetism

In addition, for the Professional Physics area of concentration, a student must complete the following supporting courses, totaling 13 credits:

PHYS 374 (4): Intermediate Theoretical Methods
2. Proposed (new) requirements.

The required courses for the new major in Physics consist of the following:

**Required Introductory Physics Sequence (17 credits)**

PHYS 165 (3): *Introduction to Programming for the Physical Sciences*  (For students with experience with computer programming this can be satisfied by a new advanced level course PHYS 474 *Computational Physics*)
PHYS 171 (3): *Introductory Physics: Mechanics and Thermal Physics*
PHYS 174 (1): *Physics Lab Introduction*
PHYS 272 (3): *Fields*
PHYS 275 (2): *Experimental Physics I: Mechanics, Heat, and Fields*
PHYS 273 (3): *Waves*
PHYS 276 (2): *Experimental Physics II: Electricity and Magnetism*

**Supporting Mathematics/Mathematical Methods Courses (15 credits)**

MATH 140 (4): *Calculus I*
MATH 141 (4): *Calculus II*
MATH 241 (4): *Calculus III*
PHYS 274 (3): Mathematical Methods for Physics I

**Physics Major - Upper Level Requirements (37 credits)**

PHYS 371 (3): *Modern Physics*
PHYS 373 (3): Mathematical Methods for Physics II
PHYS 375 (3): *Experimental Physics III: Electromagnetic Waves, Optics*
PHYS 411 (4): *Intermediate Electricity and Magnetism*
PHYS 401 (4): *Quantum Physics I*
PHYS 402 (4): *Quantum Physics II*
PHYS 404 (3): *Introduction to Statistical Thermodynamics*
PHYS 405 (3): Advanced Experiments lab
   or  PHYS 407 (3): *Undergraduate Experimental Research*
PHYS 410 (4): *Classical Mechanics*
PHYS 4xx (3): Advanced Physics Elective I
PHYS 4xy (3): Advanced Physics Elective II

3. Identification of and rationale for the changes.
a) A computational physics requirement (PHYS 165 or PHYS 474) has been added. The rationale is that computational science has become fundamental to the field both in academic research and in the industrial world. The need for a two-tier requirement stems from students entering with radically different computational backgrounds.

b) Phys 171 has been changed from Mechanics and Relativity to Mechanics and Thermal Physics. This change deals with two problems in our current curriculum. Students do not get adequate training in relativity in large part because many are not sufficiently sophisticated enough to absorb it as freshman. Relativity will be treated in a new modern physics class. At the same time, in our current scheme students have no exposure to any thermal physics until PHYS 404 as seniors. This is not ideal. With the space opened up in Phys 171 by removing relativity, a brief introduction to aspects of thermal physics becomes viable.

c) Changes to the mathematics sequence: The elimination of the MATH 240 and MATH 246 requirements are justified as they do not articulate well with the Physics program. Much of the material in the differential equations course is not used. The linear algebra course does not adequately meet the needs of Physics since it concentrates on real matrices. Conversations with Math suggested that given that physics was a small part of the clientele for 240 and 246, it was unlikely that Math could change their courses to meet the needs of Physics. The PHYS 374 course was designed as a mathematical “bridge” course to help students deal with out higher level classes, but its curriculum has been somewhat unstable—fluctuating from term to term. In the new scheme these three classes are to be replaced with two highly targeted classes taught in Physics, PHYS 274 and 373 which are specifically designed to meet the needs of our curriculum. In addition, PHYS 272 our course on waves will be used to introduce key mathematical concepts. We recognize that the Mathematics Department does not consider PHYS274 equivalent to MATH240 and 246. Students completing MATH246 and MATH240 may substitute these courses for PHYS274.

d) PHYS 371, a course on Modern Physics emphasizing relativity (with 4-vectors) and an introduction to quantum phenomena has been added. It serves, two principal purposes. The first is provide a forum in which relativity, one of the cornerstones of physics can be treated with sufficient time for students to both learn the formalism and gain intuition about the underlying science. The second is to provide an opportunity to expose students to the physical ideas on which quantum mechanics is based prior to their taking a formal course on quantum mechanics (PHYS 401). The rationale for this is that PHYS 401 can be difficult for many students since it is both formidable in terms of the mathematical formalism and the underlying physical ideas. PHYS 371 introduces many of the physical concepts using much simpler (although intrinsically incomplete) formal structures.

e) The addition of two advanced (400-level) electives to the major serves several purposes. The principal one being the exposure of students to contemporary research in the field. With our previous program, the standard undergraduate program included very little physics beyond the 1930s. This did not serve our students well. The requirement is designed to be flexible given different student needs. For example one of these two electives can be from a department related to physics (eg. Astronomy, Material Science Engineering, Electrical Engineering ...) which will allow both for a broad education and aid double majors. Core Graduate classes will also count which will aid students intending to go to graduate school.

Note: While the our proposal for the new physics major increases the count of major requirements from 61 credits to 69 credits, we think this is reasonable. Some of the other majors in CMNS (e.g., BSCI and
CMSC) require 69 or more credits of major requirements, and our new program allows students to complete in 8 semesters, with 15 credits per semester. Moreover, our plan includes nearly 20 credits of electives after completing of Gen. Ed. and major requirements -- more if students double count some of their DS requirements.

We will also allow students double majoring in another science or engineering discipline to use upper-level courses from their other major to satisfy the upper-level PHYS electives, and MATH majors may continue to use MATH240 and MATH246 in place of the first mathematical methods in physics course (PHYS274).

4. A sample program under the proposed requirements. Show how a typical student would progress through the proposed program year by year. Attention should be paid to course prerequisites to ensure that students can actually follow the prescribed program. A table illustrating the semester by semester breakdown of credits is useful.

**The Physics Major**

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Semester 2</th>
</tr>
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<tbody>
<tr>
<td>MATH 140 (AM/AR)</td>
<td>4</td>
</tr>
<tr>
<td>ENGL 101 (AW)</td>
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<td>PHYS 174</td>
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<td>Electives</td>
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<tr>
<td>GNED #1 (DS)</td>
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<tr>
<td>GNED #3 (DS)</td>
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<tr>
<td>MATH 241</td>
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<tr>
<td></td>
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<tr>
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<td>PHYS373</td>
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<td>3</td>
</tr>
<tr>
<td>PHYS165</td>
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<tr>
<td>Elective</td>
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<tr>
<td>ENGL390 (PW)</td>
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<tr>
<th>Semester 7</th>
<th>Semester 8</th>
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<tr>
<td>PHYS410</td>
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<td>3</td>
</tr>
<tr>
<td>GNED #5</td>
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</tr>
<tr>
<td>Elective</td>
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</tr>
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<td></td>
<td>30 subtotal</td>
</tr>
</tbody>
</table>
### 5a. A list, table or chart showing the prerequisite structure of all required or optional courses appearing in the new requirements.

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Req</th>
<th>Prerequisites</th>
<th>Co-requisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 140</td>
<td>Calculus 1</td>
<td>Y</td>
<td>Placement by Math Department or pass MATH 115 with C or better&lt;br&gt;MATH 140 or equivalent</td>
<td>None</td>
</tr>
<tr>
<td>MATH 141</td>
<td>Calculus 2</td>
<td>Y</td>
<td>MATH 140 or equivalent</td>
<td>None</td>
</tr>
<tr>
<td>MATH 241</td>
<td>Calculus 3</td>
<td>Y</td>
<td>MATH 141 and any one of the following: MATH 240, ENES 102, PHYS 161, PHYS 171</td>
<td>None</td>
</tr>
<tr>
<td>PHYS 165</td>
<td>Programming for the Physical Sciences</td>
<td>Y</td>
<td>PHYS 171, PHYS 141 or PHYS 161 or a 3 or higher on AP PHYS exam</td>
<td>None</td>
</tr>
<tr>
<td>PHYS 171</td>
<td>Mechanics</td>
<td>Y</td>
<td>MATH 140 and high school physics or permission of Department</td>
<td>MATH 141</td>
</tr>
<tr>
<td>PHYS 174</td>
<td>Intro Lab</td>
<td>Y</td>
<td>None</td>
<td>MATH 140</td>
</tr>
<tr>
<td>PHYS 272</td>
<td>E&amp;M</td>
<td>Y</td>
<td>PHYS 161 or PHYS 171 and MATH 141&lt;br&gt;MATH 241</td>
<td>PHYS 274</td>
</tr>
<tr>
<td>PHYS 273</td>
<td>Waves</td>
<td>Y</td>
<td>PHYS 272 and MATH 241</td>
<td>PHYS 274</td>
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<tr>
<td>PHYS 274</td>
<td>Mathematical Methods in Physics I</td>
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<td>PHYS 272 and MATH 241</td>
<td>PHYS 273</td>
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<tr>
<td>PHYS 275</td>
<td>Mechanics Lab</td>
<td>Y</td>
<td>PHYS 174, and (PHYS 161 or PHYS 171)</td>
<td>PHYS 272</td>
</tr>
<tr>
<td>PHYS 276</td>
<td>E&amp;M Lab</td>
<td>Y</td>
<td>PHYS 272 and PHYS 275</td>
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</tr>
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<td>PHYS 371</td>
<td>Modern Physics</td>
<td>Y</td>
<td>PHYS 273</td>
<td></td>
</tr>
<tr>
<td>PHYS 373</td>
<td>Mathematical Methods in Physics II</td>
<td>Y</td>
<td>PHYS 273 and PHYS 274</td>
<td>PHYS 274</td>
</tr>
<tr>
<td>PHYS 375</td>
<td>Exper. Physics III</td>
<td>Y</td>
<td>PHYS 273 and PHYS 276</td>
<td>None</td>
</tr>
<tr>
<td>PHYS 401</td>
<td>Quantum 1</td>
<td>Y</td>
<td>PHYS 273</td>
<td>PHYS 373</td>
</tr>
<tr>
<td>PHYS 402</td>
<td>Quantum 2</td>
<td>Y</td>
<td>PHYS 401, PHYS 373 and PHYS 274&lt;br&gt;MATH 241 or equivalent</td>
<td>None</td>
</tr>
<tr>
<td>PHYS 404</td>
<td>Thermodynamics</td>
<td>Y</td>
<td>PHYS 273 or equivalent and MATH 241</td>
<td>None</td>
</tr>
<tr>
<td>PHYS 405</td>
<td>Advanced Exper. Lab</td>
<td>Y</td>
<td>PHYS 375</td>
<td>None</td>
</tr>
<tr>
<td>PHYS 410</td>
<td>Mechanics</td>
<td>Y</td>
<td>PHYS 373</td>
<td>None</td>
</tr>
<tr>
<td>PHYS 411</td>
<td>E&amp;M</td>
<td>Y</td>
<td>PHYS 373</td>
<td>None</td>
</tr>
<tr>
<td>PHYS 4xx</td>
<td>Advanced Physics Elective I</td>
<td>Y</td>
<td></td>
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</tr>
<tr>
<td>PHYS 4xy</td>
<td>Advanced Physics Elective II</td>
<td>Y</td>
<td></td>
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</tbody>
</table>
5b. It may also be helpful to provide a table illustrating a sample schedule of course offerings, semester by semester, to demonstrate that, with the available and anticipated faculty, enough courses will initially be offered to allow students to progress through their programs. The schedule should allow time for the necessary development of new courses.

6. A list of any new courses: prefix, number, title, credits. New courses that have not yet been approved need not have specific numbers, but should be identified according to the desired level, such as 3**. "Selected" or "Special" topics courses should be avoided. If courses to be offered regularly in the new program are presently offered as "Selected" or "Special" topics, you should propose to make them permanent. Indicate new courses with an X. Indicate current courses that will be substantially modified as part of the program change with an M. Include a copy of the VPAC information describing these new or modified courses. It is your responsibility to insure that the new or modified course proposals are submitted for VPAC approval in a timely fashion.

7. A list of the courses being deleted from the program requirements.
   1) MATH246 - Differential Equations
   2) MATH240/461 - Linear Algebra
   3) PHYS374 - Intermediate Theoretical Methods

8. Letters from any department(s) whose courses will be required or otherwise impacted. If the change in curriculum introduces a requirement (or recommendation) that majors take a course offered by another department, it is important to establish that such a requirement will not unduly burden faculty and resources elsewhere on campus. Attach a memorandum or letter from the Chair of the affected department indicating that it can handle the additional enrollment that the curriculum change will generate.

9. It should be specifically acknowledged that students enrolled in the program prior to the effective date of any curriculum change may complete their program under the old requirements if they wish. The courses required must remain available, or suitable substitutions specifically designated. Further, if the proposed curriculum change affects articulation or transfer programs, the proposal should explain how currently-enrolled community college students will be able to complete their projected programs. Any necessary modifications to articulation agreements should be attached.

   While we do not have formal articulation agreements with community colleges and do not get many transfer students from community colleges, we recognize that the changes we propose for our program will have some impact on community college students intending to major in physics. In general, we think that students interested in the physics major would be best served by taking their physics courses at Maryland since we have a separate set of introductory courses for our majors. However, students who decide to complete their introductory physics courses at the community college can complete our upper-level sequence in four semesters as long as they complete Multivariable Calculus and Differential Equations along with the equivalent of PHYS272 and PHYS273. Students should then be prepared for Semester 5 but would need to take Linear Algebra concurrently with our Mathematical Methods for Physics II. (It would be better if these students complete Linear Algebra or take Mathematical Methods for Physics 1 prior to starting Semester 5.)
PHYS274: Mathematical Methods for Physics I

Syllabus

- **Instructor:** Zackaria Chacko
  **Office:** PHY4125
  **Phone:** (301) 405 1774
  **E-mail:** zchacko@umd.edu

- **Class meeting times:**
  Tuesday & Thursday, 2:00-3:15PM

- **Class web page:**
  http://terpconnect.umd.edu/~zchacko/Fall14/physics274.html

- **Grading Criteria:**
  20% Homework, 40% Midterms, 40% Final
  Homework will be typically assigned on a weekly basis.

- **Textbooks:**
  Mathematical Methods in the Physical Sciences, by Mary L. Boas
  A Guided Tour of Mathematical Methods for the Physical Sciences, by Roel Snieder

- **Pre-requisites:**
  MATH241, PHYS272, PHYS273 (pre/co-requisite)

- **Topics Covered:**

  **Linear Algebra**
  Linear vector spaces; linear operators and their representation as matrices; matrix algebra; determinants and their application to the solution of linear inhomogeneous equations; inner products; eigenvalues and eigenfunctions with examples of applications to physical problems; infinite dimensional vector spaces.

  **Curvilinear Coordinates and Vector Analysis**
  Curvilinear orthogonal coordinates; cylindrical and spherical coordinate systems; gradients, divergences and curls in curvilinear coordinates and their geometrical interpretation, with examples from physical systems; Gauss’s and Stoke’s theorems.
Introduction to Ordinary Differential Equations
General properties of the solution; separable equations; classification into linear and non-linear equations; linear first order equations; second order linear equations with constant coefficients.
PHYS373: Mathematical Methods for Physics II

Syllabus

• Instructor: Zackaria Chacko
  Office: PHY4125
  Phone: (301) 405 1774
  E-mail: zchacko@umd.edu

• Class meeting times:
  Tuesday & Thursday, 2:00-3:15PM

• Class web page:
  http://terpconnect.umd.edu/zchacko/Spring15/physics373.html

• Grading Criteria: 20% Homework, 40% Midterms, 40% Final
  Homework will be typically assigned on a weekly basis.

• Textbooks:
  Mathematical Methods in the Physical Sciences, by Mary L. Boas

• Pre-Requisite(s):
  PHYS372

• Topics Covered:

  Fourier Analysis
  Fourier series; Fourier transforms; interpretation of Fourier series and
  transforms in terms of infinite dimensional linear vector spaces.

  Power Series Solution of Differential Equations
  Power series method; Legendre differential equation; Legendre polyno-
  mials and their properties; Associated Legendre functions; generalized
  power series and the Frobenius method; Bessel's equation; Bessel func-
  tions and their properties; Fuch's theorem; Sturm-Liouville theory.

  Partial Differential Equations
  Method of separation of variables; application to physical problems in
  Cartesian, cylindrical and spherical coordinate systems.

  Complex Analysis
  Analytic functions; Cauchy-Riemann conditions; poles and branch cuts;
complex line integrals; Cauchy's theorem and Cauchy's integral formula; Laurent series; residue theorem and its application to definite integrals.
Physics 171 / 171H
Introductory Physics: Mechanics and Thermodynamics
Fall 2013 — Professor XXXX

Course topics:
Kinematics, Newton's laws, gravity, energy and work, linear momentum, special relativity, rotational kinematics, angular momentum, static equilibrium, elasticity, fluids, gases, and basic thermodynamics. This course is designed for physics majors and those desiring a rigorous preparation in the physical sciences. Knowledge of basic calculus will be assumed.

Prerequisites:
Math 140 (Calculus I) and a high school physics class, or permission of the department.

Lectures:
Mondays, Tuesdays, Thursdays, and Fridays from 9:00-9:50 in room 1201 of the Physics Building. Note that Physics 171 and Physics 171H (the honors section) share the lectures. Students in 171H also have a weekly discussion session: Tuesday 3:00-3:50, Wednesday 10:00-10:50, or Wed. 4:00-4:50.

Class attendance is important, and I expect you to come to class and to participate for your own benefit and enjoyment. I plan to make the class time fairly interactive, and we’ll often talk about things which are not in the book. I do not attempt to keep records of class attendance.

Required textbook:
“Physics for Scientists & Engineers” by Douglas C. Giancoli, 4th edition, chapters 1-37, bundled with MasteringPhysics access kit. The ISBN number (for this book + access kit package) is 0-1361-3926-4 (ISBN-10) or 9-780-1361-3926-3 (ISBN-13). The MasteringPhysics access in this package includes both the online homework/tutorial system (required for the course) and an eBook subscription that is handy when you want to study somewhere without lugging the actual book around. Be careful to get the right package! The publisher produces other versions of this book (split into volumes; with additional chapters for modern physics topics; etc.) The ISBN number above is the simplest way (though not the only way) to get what you need for this course. The suggested retail price for this package is $197, but I believe the University Book Center and Maryland Book Exchange are selling it for $187.05 and $184.50, respectively. If you’re unsure about whether another version is sufficient, please check its ISBN number with me.

Note that if you buy a used copy of the book, it probably will not include an unused MasteringPhysics kit, so you will have to purchase access separately. At www.masteringphysics.com you can purchase access to the online homework/tutorial system for $45 without the eBook or for $121 with the eBook. Thus, the financial benefit of buying a used book—if any!—will probably be small, unfortunately.

Another option for cutting costs, at least in principle, is to purchase an eBook subscription without a physical book. Besides the MasteringPhysics option mentioned above ($121), www.coursesmart.com offers a somewhat more readable eBook version for $97; combined with the separate MasteringPhysics homework/tutorial system subscription, that’s a total of $142. However, I strongly recommend buying a physical book instead of just an eBook subscription! First of all, the higher-quality type in a printed book is easier to read than pixels on a screen, and a physical book is easier to flip through. Second, the eBook subscriptions expire after 18 or 24 months, and then you have nothing to show for the money you spent. As you go on in physics or another scientific or technical field, it is nice to have an introductory physics textbook to refer to from time to time.
Reading assignments will be given for nearly every class day, typically consisting of about 10 pages from the textbook. I will assume that you have done the reading before coming to class, and will not repeat everything that is in the book. Understanding all of the material in the readings, even if not covered in the lectures, is an important part of the course. For instance, you should be able to answer all of the Questions at the end of each chapter, even if not assigned as homework.

Feel free to read ahead by a few days! You could, for instance, do all of a week’s reading in two sittings if you prefer. Note that if you don’t have time to completely absorb a reading assignment before class, it will be best to at least read it quickly beforehand and then return to it later.

Homework:
There will usually be two homework assignments each week, each of which must be completed by the beginning of class on the specified date. Students in 171H will have extra homework problems to do. Much of the homework will use the MasteringPhysics online system, but you will also turn in handwritten problems on paper to be checked. The details of how that will work will be explained during the first class session. You can work on the homework together with a classmate as long as the end result is that you master the material and turn in your own work. Copying is cheating; on the other hand, having a friend help you figure out how to solve a problem can be a good learning strategy.

Don’t wait until the last minute to start a homework assignment! In fact, try to start it early so that you can ask for help if you need it. Please do all of the homework and turn it in on time, unless you have a valid excuse (i.e. illness, a religious observance, or some other compelling reason). I know that things sometimes come up (e.g., exams and important deadlines in other courses), so I will give you four free extension days to use during the semester with no excuse necessary. Beyond that, if you do not have a valid excuse, you can still turn in the homework up to 24 hours late for half credit; after 24 hours, no credit will be given.

Exams:
There will be four exams during the semester plus a final exam. Note that the date and time of the final exam have not yet been decided by the University; we should find out the schedule in early November. The exams will be given in class, on paper, and will be closed-book. Any physical constants or data that you may need will be provided. You will need a calculator with standard trigonometry functions. Exams must be taken on the scheduled days unless you have a valid excuse. If you know in advance that you will have to miss an exam, please inform me as soon as possible so that we can arrange a make-up. Note that the make-up exam will be identical to the regular exam; I will trust you and your classmates to not allow the contents of the exam to leak out to someone who still has to take it.

Course grade:
40% Homework
40% Exams during the semester (i.e. 10% each)
20% Final exam

How to do well in this course:
Come to the lectures. Participate in class discussions. Keep up with the reading—try to read some at least three or four times per week. Start the homework early enough so that you can finish it all. Ask for help (your teacher, TA, or a classmate) whenever there is something you don’t understand. Also ask about anything you are curious about. Review your notes and past homeworks before each exam.
Contact Information:
Prof. XXX, room YYY in the Physics Building, 301-405-???, ???@umd.edu
Office hours: to be announced
TA: to be announced
Office hours: to be announced
*** NOTE: Office hours are subject to change – watch for announcements
If you are unable to come during regular office hours, please contact me by email or phone to ask
a question and/or arrange a time to meet.

Course Evaluations:
As you probably know, the University of Maryland has a system called CourseEvalUM
which collects information from students about the quality of courses and the effectiveness
of instructors, and provides online summaries at Testudo for students to view when they are
preparing to register for future semesters. This can be a valuable resource for you and for other
students, but it depends on your participation! Your feedback is confidential and important to
the improvement of teaching and learning at the University as well as to the faculty tenure and
promotion process. The CourseEvalUM web site, www.courseevalum.umd.edu, will be open for
you to complete your evaluations for fall semester courses between ???? and ??? (i.e. it closes
before final exams begin). It is important to complete all of your evaluations each semester to
provide a complete picture of each class and also because if you don’t, you will lose the privilege
of accessing the summary reports in the following semester.

Honor Code:
The University of Maryland has a nationally recognized Code of Academic Integrity,
administered by the Student Honor Council. This Code sets standards for academic integrity
at Maryland for all undergraduate and graduate students. As a student you are responsible
for upholding these standards for this course. It is very important for you to be aware of the
consequences of cheating, fabrication, facilitation, and plagiarism. For more information
on the Code of Academic Integrity or the Student Honor Council, please visit http://
www.studenthonorcouncil.umd.edu/whatis.html

Religious observances:
If you need to miss class, a homework deadline, or an exam due to a religious observance, please
notify me in advance—preferably at the beginning of the semester.

Students with disabilities:
Accommodations will be provided to enable students with disabilities to participate fully in the
course. Please discuss any needs with me at the beginning of the semester so that appropriate
arrangements can be made.

Weather and emergency closures:
If the University is closed due to weather or some emergency situation on a day when homework
is due, then that homework must be turned in at the beginning of the next class when the
University is open. If the University is closed on the scheduled date of an exam, then the exam
will be given during the next class period when the University is open. If the University is closed
on any non-exam day, including a review session (the class immediately before an exam), then
the exam will still be given according to the original schedule. In these or other exceptional
circumstances, I will attempt to send out information by email.
Physics 371
Introductory Modern Physics
Fall 2013 — Professor XXXX

Course topics:
The fourth semester of the introductory sequence for physics majors, this modern physics course introduces special relativity and elementary aspects of quantum physics. Using 4-vector notation, the relativity part will consider time dilation, length contraction, mass enhancement, mass-energy relation, etc. The quantum part will focus on failures of the classical picture and how quantum mechanics, especially the early versions, accounts for observed phenomena. Examples include: spectral lines and the Bohr atom, spectral dependence of blackbody radiation and the Planck distribution, photo electric effect and photons (and metallic work functions), radioactivity, fission and fusion. More generally, it will cover some highlights of molecular, solid state, nuclear, elementary-particle, and cosmological physics.

Prerequisites:
Physics 273/276.

Lectures:
Mondays, Tuesdays, Thursdays, and Fridays from 9:00–9:50 in room 1201 of the Physics Building.

Class attendance is important, and I expect you to come to class and to participate for your own benefit and enjoyment. I plan to make the class time fairly interactive, and we’ll often talk about things which are not in the book. I do not attempt to keep records of class attendance.

Required textbook:
“Physics for Scientists & Engineers” by Douglas C. Giancoli, 4th edition, chapters 1-37, bundled with MasteringPhysics access kit. The ISBN number (for this book + access kit package) is 0-1361-3926-4 (ISBN-10) or 9-780-1361-3926-3 (ISBN-13), used in the previous three courses in this sequence, has modern physics in the last few chapters. This will be supplemented by a textbook on special relativity and another on modern physics.

Examples of texts on special relativity are:
Special Relativity (M.I.T. Introductory Physics) by A.P. French
Special Relativity by T.M. Helliwell

Examples of texts on modern physics are:
Modern Physics by R.A. Serway, C.J. Moses, C.A. Moyer
Modern Physics for Scientists and Engineers (2nd Edition) by John Taylor, Chris Zafiratos, Michael A. Dubson
Modern Physics for Scientists and Engineers, by John Morrison
Modern Physics for Scientists and Engineers, by Stephen T. Thornton
Reading assignments will be given for nearly every class day, typically consisting of about 10 pages from the textbook. I will assume that you have done the reading before coming to class, and will not repeat everything that is in the book. Understanding all of the material in the readings, even if not covered in the lectures, is an important part of the course. For instance, you should be able to answer all of the Questions at the end of each chapter, even if not assigned as homework.

Feel free to read ahead by a few days! You could, for instance, do all of a week’s reading in two sittings if you prefer. Note that if you don’t have time to completely absorb a reading assignment before class, it will be best to at least read it quickly beforehand and then return to it later.

Homework:
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Don’t wait until the last minute to start a homework assignment! In fact, try to start it early so that you can ask for help if you need it. Please do all of the homework and turn it in on time, unless you have a valid excuse (i.e. illness, a religious observance, or some other compelling reason). I know that things sometimes come up (e.g., exams and important deadlines in other courses), so I will give you four free extension days to use during the semester with no excuse necessary. Beyond that, if you do not have a valid excuse, you can still turn in the homework up to 24 hours late for half credit; after 24 hours, no credit will be given.

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There will be four exams during the semester plus a final exam. Note that the date and time of the final exam have not yet been decided by the University; we should find out the schedule in early November. The exams will be given in class, on paper, and will be closed-book. Any physical constants or data that you may need will be provided. You will need a calculator with standard trigonometry functions. Exams must be taken on the scheduled days unless you have a valid excuse. If you know in advance that you will have to miss an exam, please inform me as soon as possible so that we can arrange a make-up. Note that the make-up exam will be identical to the regular exam; I will trust you and your classmates to not allow the contents of the exam to leak out to someone who still has to take it.

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40% Homework
40% Exams during the semester (i.e. 10% each)
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Notes about MasteringPhysics
Physics 171 / 171H —

Registering
Assuming that you bought the specified version of the textbook, it should have been packaged with a slim cardboard “Student Access Kit” for MasteringPhysics. Inside it are an access code and instructions for registering. (If you bought a version of the book that didn’t come with an Access Kit, you can purchase access on the MasteringPhysics web site.) Go to www.masteringphysics.com and follow the directions in the Access Kit. The first step is to register: you’ll choose a username and password, and enter your name, email address, and school (choose United States, zip code 20742, and then select “UNIV MARYLAND COLLEGE PARK”). Once you have registered, you can log in and “join” our specific course. Enter your Student ID (the 9-digit number on the front of your University ID card, beginning with either “10” or “11”) and the Course ID:XXXX2013PHYS171 if you are in the regular section, or XXXX2013PHYS171H if you are in the honors section.

Using MasteringPhysics
When you log in, you will see a screen with “Assignments” and some other tabs along the left edge, and “Home” and a few other links at top right. One of the links at top right is “Help”, which will give you information about navigating the web interface, etc. The first homework assignment (“HW 0”, which you’ll see when you click on “Assignments”) is a tutorial which teaches you how to use MasteringPhysics. Each assignment contains a number of “items”, and a given item can contain multiple parts. When you have done all of the parts for an item, be sure to click on the “submit item” button at the bottom of the page. When you do that, you will see your score for the item, which is calculated from the average score from the individual parts. There is also an “Item Survey” which gives you an opportunity to provide feedback to me on the item; you don’t normally have to do that, but it’s there if you want to.

How assignments will be graded
MasteringPhysics automatically calculates grades based on your answers, but the rules for giving partial credit can be confusing. Here is how I plan to set up the grading:

• You get a maximum of six attempts to answer each part. For symbolic or numeric questions, each wrong answer before the correct one reduces your score on that part by 10%. For multiple-choice questions, each wrong answer before the correct one reduces your score by the fraction $1/(n-1)$, where $n$ is the number of answer choices.

• There is no penalty for opening a hint. However, if you answer the part correctly without opening a hint, you get a bonus of 3% per unopened hint. (You can even look at the list of hint topics without actually opening any of them.)

• If you open a hint that contains a question, and you answer that question incorrectly, then your score is reduced by 10%. There is no penalty for leaving a hint question unanswered.

You can click on “Grading Policy” link at the top of an assignment to check the settings that apply to the assignment. If you think you have lost points unfairly for some technical reason, let me know what happened and I will look at your answers and make an adjustment if appropriate. Note that my provisions for extension days (four free) and unexcused late homework (half credit if turned in up to 24 hours late) won’t be handled by MasteringPhysics, but will have to be
adjusted manually.
**PHYS 415: Nonlinear Dynamics of Extended Systems**

This is a topics course in complex extended systems aimed at upper level undergraduates. Broadly speaking, a complex system is a set of interacting elements that are nonlinearly coupled to give rise to emergent behavior. This course primarily focuses on how a physics perspective coupled with a computational approach can lend insights into complex systems as they appear in a variety of contexts.

Pre-requisites include PHY372 (Mathematical Methods of Physics I), PHYS404 (Introduction to Statistical Thermodynamics) and PHYS165, or other demonstrated programming proficiency.

Problem sets will include numerical calculations and simple simulations, which means either writing code in a scientific programming language or using a standard software package such as Matlab or Mathematica. There is no required textbook. Rather, we will work from a series of research papers. Links to these papers will be posted to the website.

Grading: Problem sets: 40% (4 total, 10% each); literature presentation: 10% (Research papers will be assigned to pairs of students to present and discuss); class participation: 5%; final project: 45% (Students will identify a line of original research in the area of complex systems and write a report that includes: motivation of the problem, relevant background, an outline for the proposed work, and some preliminary investigations).

**Topics:**

* **Topic Area 1:** A Physics Approach to Biological and Social Systems: Some Examples
  - Scaling in biological systems
  - Econophysics
  - Physics of cancer
* **Topic Area 2:** Simple Models of Complex Systems
  - Cellular automata
  - Agent-based modeling
* **Topic Area 3:** Power Law Distributions in Natural Systems
  - Simple mechanisms for generating power law distributions
  - Critical phenomena in percolation
  - Self-organized criticality (SOC)
  - Highly-optimized tolerance (HOT)
* **Topic Area 4:** Complex Networks
  - Network measures
  - Network models
  - Network algorithms
  - Network dynamics
* **Topic Area 5:** Computational Tools for Complex Systems
  - Simulated Annealing and Genetic Algorithms
  - Computational Mechanics
Suggested Readings:
(a more updated list including dates for the various readings will be kept on the website)

Books:
  * Lectures on Complex Networks, S. N. Dorogovstev
  * Modeling Complex Systems by Nina Boccara,
  * Complex Systems Dynamics by Gerard Weisbuch

Power Laws:


Econophysics:

Cellular Automata: *Cellular Automata Modeling of Physical Systems* by Chopard and Droz

  * see also Weisbuch

Percolation theory: *Introduction to Percolation Theory* by Stauffer and Aharony

Self-Organized Criticality: *Self-Organized Criticality* by Jensen

Highly Optimized Tolerance:

Complex Networks

Computational Mechanics:
  * [http://hornacek.coa.edu/dave/Tutorial/notes.pdf](http://hornacek.coa.edu/dave/Tutorial/notes.pdf) by Dave Feldman
PHYS474: Computational Physics

COURSE DESCRIPTION:

This course provides an overview of some of the most widely used methods of computational physics, including numerical integration (elementary algorithms and Monte Carlo techniques), numerical solutions of differential equations (classical equations of motion, time independent and time dependent Schrodinger equations), molecular dynamics simulations (classical many-body systems), and Monte Carlo simulations (classical models of magnetism). In addition to giving the students a basic working knowledge of these particular techniques, the goal is to make them proficient in scientific computing and programming in general, so that they will be prepared to tackle also other computational problem that they may encounter in the future. The MATLAB programming language will be used.

PREREQUISITES:

PHYS403 (Introduction to Statistical Thermodynamics), PHYS372 (Mathematical Methods of Physics I), and one introductory programming course from the following list: PHYS165, CMSC 106, 114, 131, 132, ENAE 202, ENEE 114, or ENEE150 (A student may be exempt from this requirement if he or she can demonstrate adequate programming knowledge from prior course or work experience).

COURSE SOFTWARE:

MATLAB: We will be using Matlab for this class. Problem sets will require that you have access to a computer with Matlab installed. You may want to purchase a student edition of Matlab or simply use the computer labs on campus. Alternatively, you can use the university’s virtual computer lab to use Matlab remotely. This allows you to run Matlab without having it installed on your local computer. For information on using the virtual computer lab go to the following page:

http://eit.umd.edu/vcl

Also note that many of the problems on the problem sets can be done using FreeMat, a free software package designed to emulate Matlab. FreeMat can be downloaded at:

http://freemat.sourceforge.net/download.html

REQUIRED TEXTBOOK:

A First Course in Computational Physics by Paul DeVries.

Note: While many of the topics covered in class are also presented in the textbook, some topics addressed in the lectures are not included in the textbook. You are responsible for all material covered in class and all assigned textbook readings.

ADDITIONAL REFERENCES:

- An Introduction to Computational Physics, by Tao Pang
- Computational Physics by Nicholas Giordano
• *An Introduction to Computer Simulation Methods*, H. Gould and J. Tobochnik
• *Physical Modeling in Matlab*, A. Downey. Can be purchased online or downloaded for free at: http://www.green teaDress.com/matlab/

**EVALUATIONS:**

1. **Problem sets:** 8 total
2. **Mid-semester exams:** 2 in class exams
3. **Programming Project:** Due the last week of class. In class presentations during the last two class periods. Your final programming project will require you to choose simulating a physical system involving either multiple interacting elements or stochastic processes. You will write a computer program to calculate the system behavior. Your submission will include a written description of your problem and your approach, as well as your code. You will also describe and demonstrate your program in a 5-10 minute presentation for the class. Additional details to follow.
4. **Final Exam:** during the regular final exam period.

**GRADING:**

- Problem sets: 30%
- In class exams (2): 15% each
- Programming project: 20%
- Final Exam: 20%

Participation and attendance will count toward borderline grade cases.

**ACADEMIC HONESTY:**

Working together on assignments is encouraged. However, each student is expected to do the assigned problems and write the assigned programs independently, and hand in his or her own work for grading. If you work with other students on a problem set, you must list their names on the first sheet of your submitted solutions. Examinations are to be worked completely independently.

**MATERIAL (Approximate times indicated in italics):**

- Introduction to scientific computing: variables, arrays, functions, random numbers, etc. (1 week)
- Numerical approximation: curve fitting by least-squares, interpolation. (1.5 weeks)
- Numerical calculus: differentiation, integration, root-finding (1.5 weeks)
- Methods for integrating ODE’s. ODE examples: pendulum, celestial mechanics, 1D Schrodinger, etc. (2 weeks)
- Methods for solving PDE’s. PDE examples: diffusion equation, wave equation, etc. (3 weeks)
- Molecular Dynamics simulations: basic methods for many body systems, the Verlet algorithm. (3 weeks)
- Monte Carlo simulations: sampling and integration, spin systems (3 weeks)