November 11th, 2015

The Department of Physics & Astronomy is proposing the creation of a new upper-level course, Physics Problem Solving (PHYS 481). This new course is designed to teach general problem solving skills, with a particular emphasis on helping graduate-school bound students prepare for the Advanced Physics GRE examination.

The motivation for this course is presented in detail in the cover letter for the course creation form. In brief, this course allows our students to obtain training to help students succeed on the Advanced Physics GRE via use of several discipline-targeted problem solving techniques.

This course has been offered several times in the past as a special topics course, and will not require any cost to the department or the college.

Attached to this cover letter is (in order):

1. A cover letter for the course creation form.
2. The course creation form.
3. A copy of the proposed course syllabus
4. A cover letter for the Physics B.S. Change of Major Form
5. The Physics B.S. Change of Major Form
6. The Physics B.S. Program of Study Worksheet to Support the Physics B.S. Change of Major Form
7. A cover letter for the Physics B.A. Change of Major Form
8. The Physics B.A. Change of Major Form
9. The Physics B.A. Program of Study Worksheet to Support the Physics B.A. Change of Major Form

Thank you for your time and consideration.

[Signature]

Michael L. Larsen
Assistant Professor of Physics and Astronomy
The Department of Physics & Astronomy is proposing the creation of a new upper-level course, Physics Problem Solving (PHYS 481). This new course is designed to teach general problem solving skills, with a particular emphasis on helping graduate-school bound students prepare for the Advanced Physics GRE examination.

A large fraction of Physics and Astrophysics graduate programs require the Advanced Physics GRE, which is a comprehensive exam that seeks to assess mastery of Physics at the undergraduate level via a 170 minute, 100 question multiple choice exam.

The format of this exam is unusual compared to normal course assessments in the field of Physics and Astronomy; most Physics exams involve a few detailed, multiple-part questions delving into substantial detail on a topic. The Advanced Physics GRE, however, allows an average of only 102 seconds per question, requiring rapid thought on an extremely wide variety of topics.

By the time students enroll in this course, it is too late to substantially improve their overall Physics knowledge. (This course is intended to be taken by undergraduate seniors; if 2 previous years of intense undergraduate coursework have failed to develop the quantitative understanding necessary for success, a 1 credit Express I course will not fix the problem). Rather, the goal of the course is to help students develop familiarity with using the tools of scaling, dimensional analysis, limiting cases, and symmetry to help them more effectively leverage the Physics knowledge they already have for this testing environment.

In addition to working through sample (retired) GRE practice exams, the course also includes a brief section where students work through so-called “Fermi Problems”. These open-ended questions are famous in the fields of Physics and Astronomy and often use many of the same central skills that we are hoping to develop in this class (e.g. the use of scaling, dimensional analysis, limiting cases, and symmetry).

Finally, the department gathers student results from the practice exams for use in departmental self-assessment.

The department has offered this course (under various names) as a special topics course multiple times in the past 5 years. Enrollment has been good for an upper-level Physics elective (approximately 50 students have taken the special topics version of the course), and students report that they believe it has helped them do better on the real Physics GRE.

Since this course has been offered consistently as a special topics course for some time, there is no net overall cost to the department or the university in creating this course. We propose this class to be offered as an “Express I” course in order to maximize the amount of instructional time between the beginning of Fall Semester and the advanced GRE subject testing dates (which move around a little from year to year, but this year were September 19th and October 24th).

Thank you for your time and consideration,

Michael L. Larsen
Assistant Professor of Physics and Astronomy
FACULTY CURRICULUM COMMITTEE
COURSE FORM

Instructions:
- Please fill out one of these forms for each course you are adding, changing, deactivating, or reactivating.
- Fill out the parts of the form specified in part B. You must do this before your request can move forward!
- Remember that your changes will not be implemented until the next catalog year at the earliest.
- If you have questions, start by checking the instructions on the website. Please feel free to contact the committee chairs with any remaining questions you might have.

A. CONTACT/COURSE INFORMATION.

Name: Michael L. Larsen
Phone: 843-953-2128
Email: LarsenML@cofc.edu

Department or Program: Physics and Astronomy
School: SSM

Subject Acronym and Course Number: PHYS 481

Catalog Year in which changes will take effect: FALL 2016

B. TYPE OF REQUEST. Please check all that apply, then fill out the specified parts of the form.

☑ Add a New Course (complete parts C, D, F, G, H, I, J)
☐ Change Part of an Existing Course (complete parts C, D, E, F, G, I, J)
  ☐ Course Number (you must submit a course deactivation request for the old course number)
  ☐ Course Name
  ☐ Course Description
  ☐ Credit/Contact Hours
  ☐ Restrictions (prerequisites, co-requisites, junior/senior standing, etc.)
☐ Deactivate an Existing Course (complete parts C, D, E, G, I, J)
☐ Reactivate a Previously-Deactivated Course (complete parts C, D, E, G, I, J)

C. RATIONALE AND EXPLANATION. Please describe your request and explain why you are making it.

As noted in more detail in the cover letter, we propose the creation of this course in order to assist students in developing effective test-taking strategies for the Advanced Physics GRE exam. In particular, this course is designed to help instruct students how to leverage their current Physics background and use the particularly powerful skills of dimensional analysis, scaling, limiting cases, and symmetry to quickly (i) rule out unphysical multiple-choice answers, and (ii) give insight to problems where time or physics knowledge may otherwise leave the student without much chance of answering a problem successfully.

This course has already run several times with good success as a special topics course. We see no reason to stop offering the course, so we wish to make it a regular catalog course.

D. IMPACT ON EXISTING PROGRAMS AND COURSES. Please briefly describe the impact of your request on your own programs and courses as well other programs and courses. If another program requires the course, you must submit their written acknowledgement with this proposal. Also, the affected program must describe any change in the number of credit hours they require. Include a list of similar courses in other departments and explain any overlap.

This course will only count as an elective within the Physics B.S. and Physics B.A. programs. As a special topics course, the course has already acted as an elective within these programs.

This form was last updated on 12/13/13 and replaces all others.
E. EXISTING COURSE INFORMATION. If you are proposing a new course, just leave this blank. Otherwise, please fill out all fields.

Department: 
School: 
Subject Acronym: 
Course Number: 
Credit hours: ___ lecture ___ lab ___ seminar ___ independent study 
Contact hours: ___ lecture ___ lab ___ seminar ___ independent study 
Course title: 
Course description (maximum 50 words, exactly as it appears in the catalog):

Restrictions (pre-requisites, co-requisites, majors only, etc.): 
Cross-listing, if any: 
Is this course repeatable? □ yes □ no If yes, how many total credit hours may the student earn? _____

F. NEW COURSE INFORMATION. If you are deactivating a course, leave this blank. Otherwise, please fill out all fields. For changed courses, use boldface for the information that is changing.

Department: Physics and Astronomy School: SSM Subject Acronym: PHYS Course Number: 481 
Credit hours: ___ lecture ___ lab ___ seminar ___ independent study 
Contact hours: ___ lecture ___ lab ___ seminar ___ independent study [2 contact hours/week in Express 1] 
Course title: Physics Problem Solving 
Course description (maximum 50 words, exactly as it appears in the catalog):

Physicists are problem solvers. Often, a full solution to a system is unnecessary to grasp the central elements of a problem. This course utilizes the basic tools of symmetry, limiting cases, scaling, and dimensional analysis to engage in problem solving exercises where speed is more important than a closed-form solution.

Restrictions (pre-requisites, co-requisites, majors only, etc.): Prerequisite or Corequisite: PHYS 370 or ASTR 377 
If this is a newly-created course, is it intended to be the equivalent of an existing course? □ yes □ no 
If so, which course? ___________ 
If equivalent, will the newly-created course replace the existing course? □ yes □ no 
Note: If yes, you must deactivate that course by submitting an additional Course Form. 
Cross-listing, if any (submit approval from relevant department): ___________ 
Note: Cross-listed courses are equivalent. 
Is this course repeatable? □ yes □ no If yes, how many total credit hours may the student earn? _____

Is there an activity, lab, or other fee associated with this course? □ yes □ no What is the fee? $______ 
Note: The Senate cannot approve new fees; Business Affairs will submit any such request to the Board of Trustees. The course can still be created, but the fee will not be attached until the Board has approved it.
G. COSTS. List all of the new costs or cost savings (including new faculty/staff requests, library, equipment, etc.) associated with your request.

Since this course has been regularly taught as a special topics for several years, there are no new costs associated with this request.

H. STUDENT LEARNING OUTCOMES AND ASSESSMENT.

<table>
<thead>
<tr>
<th>Student Learning Outcomes</th>
<th>Assessment Method and Performance Expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>What will students know and be able to do when they complete the course?</td>
<td>How will each outcome be measured? Who will be assessed, when, and how often? How well should students be able to do on the assessment?</td>
</tr>
<tr>
<td>1. Successful students will demonstrate substantial improvement in sample Physics subject GRE test performance.</td>
<td>Students will take 5 sample GRE exams. Their improvement over time will be monitored. Our goal is to raise the average sample test scores of our students by 10 percentage points from the first sample test to the final sample test.</td>
</tr>
<tr>
<td>2. Successful students will be able to professionally present solutions to both pre-prepared and extemporaneous &quot;Fermi Problems&quot;</td>
<td>All students will be required to present a prepared and an extemporaneous Fermi problem to the class at the end of the semester. The goal is for all answers to be accurate to within an order of magnitude.</td>
</tr>
<tr>
<td>3. Successful students will be able to identify their own personal areas of weakness on GRE-type tests to help target their studying patterns for subject GRE and Major Field Test Assessments</td>
<td>Each student will be asked to write brief reflective statement after taking examinations. Based on these statements and the score breakdown by subject, we will evaluate the student's success at identifying their own areas of weakness. The goal is for all students to be able to identify their weakest two sub-disciplines on each exam.</td>
</tr>
<tr>
<td>4. Successful students will be able to discard incorrect proposed solutions to complex physics problems by using symmetry, limiting cases, scaling, and dimensional analysis.</td>
<td>These outcomes are also evaluated by examining performance on the practice subject GRE exams over time. Our goal – in tandem with goal number 1 above – is to raise average sample test scores of our students by 10 percentage points from the first sample test to the final sample test.</td>
</tr>
</tbody>
</table>

How does this course align with the student learning outcomes articulated for the major, program, or general education? What program-level outcome or outcomes does it support? Is the content or skill introduced, reinforced, or demonstrated in this course?

This course directly goes to supporting Student Learning Outcomes 1 and 4 within the Physics B.S. and Outcomes 1 and 4 within the Physics B.A. SLO 1 (demonstrating conceptual understanding of basic ideas in classical and modern physics) and SLO 4 (Career based outcomes) are both reinforced in this course.
I. PROGRAM CHANGES. Will this course be added to the existing degree requirements or list of approved electives of a major, minor, or concentration? ☒ yes ☐ no

If yes, please attach a Change Minor and/or Change Major/Program Form as appropriate.

J. CHECKLIST.

☒ I have completed all relevant parts of the form.

☒ I have attached a cover letter that describes my request and lists all the documents I am submitting.

☒ (For new courses only) I have attached a syllabus.

☐ (For courses used in any way by other departments, including cross-listing) I have attached an acknowledgement from the relevant department.

☐ (For courses intended to fulfill a Gen Ed requirement) I have submitted the proposal to the Gen Ed committee.

☒ I have submitted one Signature Form that lists all of the different forms I am submitting.
PHYS 481: Physics Problem Solving

Instructor: Dr. Michael L. Larsen
Email: LarsenML@cofc.edu
Phone: 843-953-2128
Office: JC Long, room 217
Credits: 1
Term: Express I (Fall Semester) (Course meets 2 hours/week during Express I)

COURSE DESCRIPTION
Physicists are problem solvers. Often, a full solution to a system is unnecessary to grasp the central elements of a problem. This course utilizes the basic tools of symmetry, limiting cases, scaling, and dimensional analysis to engage in problem solving exercises where speed is more important than an exact closed-form solution. (This is a 1 credit course that meets 2 hours/week during Express I in Fall).

PRE or CO-REQUISITE
PHYS 370 or ASTR 377

COURSE OBJECTIVES
1. Broadly review basic content from introductory and intermediate-level Physics courses.
2. Discuss the nature of the Physics Subject GRE test including the purpose of the exam, deadlines (including how they relate to graduate school application timetables), test-taking strategies, and the exam format (including topics covered).
3. Discuss and practice applying the basic tools of symmetry, limiting cases, scaling, and dimensional analysis to a variety of standard undergraduate-level Physics problems, including problems in areas where students have had little or no previous formal instruction.
4. Collaboratively work through problems on retired GRE examinations by combining previous Physics knowledge with skills developed elsewhere in the course.
5. Solve so-called “Fermi Problems” (collaboratively and individually).

LEARNING OUTCOMES
1. Successful students will demonstrate substantial improvement in sample Physics subject GRE test performance.
2. Successful students will be able to professionally present solutions to both pre-prepared and extemporaneous “Fermi Problems”.
3. Successful students will be able to identify their own personal areas of weakness on GRE-type tests to help target their studying patterns for subject GRE and Major Field Test assessments.
4. Successful students will be able to discard incorrect proposed solutions to complex physics problems by using symmetry, limiting cases, scaling, and dimensional analysis.
GRADING
Grades will be based on the following components:

1. Attendance and Participation (15%)
   Attendance in this class is critical to the student experience. The skills to be developed in this class rely on practice which will include carefully designed dialogue between students and the instructor. The instructor uses counter-examples to demonstrate how the central tools used in this course (symmetry, limiting cases, scaling, and dimensional analysis) apply to each problem. Since each problem applies these ideas in slightly different ways, students must be present for these discussions to develop an understanding of the course content.

2. Completion and Self-Evaluation of 5 Sample GRE Exams (70% total)
   Each of the 5 Sample GRE exams is 100 questions, which the student has 2 hours and 50 minutes to answer. The completion of these tests will, thus, take a total of just under 14.5 hours (outside of class). Students will be expected to also write a brief (1-2 paragraph) reflection on each sample testing experience.

3. Preparation and Presentation of Fermi Problem (15%)
   Each student will be tasked with preparing and presenting a professional solution to a so-called “Fermi Problem”. The presentations will include the prepared Fermi Problem (70%) and a solution of an extemporaneously posed problem (30%). Presentations will be graded for clarity, accuracy, and appropriate use of skills developed in the class. The prepared presentation will be expected to be approximately 5-10 minutes in duration, and include pre-prepared audio-visual aids.

GRADING SCALE
The grading scale applied to this class will be:
A: 91-100  C+: 79-80  D+: 60-61
A-: 90-91   C: 71-79   F: <60
B+: 89-90   C-: 70-71
B: 81-89    D+: 69-70
B-: 80-81   D: 61-69

STUDENTS WITH DISABILITIES
The College will make reasonable accommodations for persons with documented disabilities. Students should apply for services at the Center for Disability Services/SNAP located on the first floor of the Lightsey Center, Suite 104. Students approved for accommodations are responsible for notifying me as soon as possible and for contacting me one week before accommodation is needed.
COLLEGE OF CHARLESTON HONOR CODE AND ACADEMIC INTEGRITY

Lying, cheating, attempted cheating, and plagiarism are violations of our Honor Code that, when identified, are investigated. Each incident will be examined to determine the degree of deception involved. Incidents where the instructor determines the student’s actions are related more to a misunderstanding will handled by the instructor. A written intervention designed to help prevent the student from repeating the error will be given to the student. The intervention, submitted by form and signed both by the instructor and the student, will be forwarded to the Dean of Students and placed in the student’s file.

Cases of suspected academic dishonesty will be reported directly by the instructor and/or others having knowledge of the incident to the Dean of Students. A student found responsible by the Honor Board for academic dishonesty will receive a XF in the course, indicating failure of the course due to academic dishonesty. This grade will appear on the student’s transcript for two years after which the student may petition for the X to be expunged. The F is permanent. The student may also be placed on disciplinary probation, suspended (temporary removal) or expelled (permanent removal) from the College by the Honor Board.

Students should be aware that unauthorized collaboration—working together without permission—is a form of cheating. Unless the instructor specifies that students can work together on an assignment, quiz and/or test, no collaboration during the completion of the assignment is permitted. Other forms of cheating include possessing or using an unauthorized study aid (which could include accessing information via a cell phone or computer), copying from others’ exams, fabricating data, and giving unauthorized assistance. Research conducted and/or papers written for other classes cannot be used in whole or in part for any assignment in this class without obtaining prior permission from the instructor.

Students can find the complete Honor Code and all related processes in the Student Handbook at http://studentaffairs.cofc.edu/honor-system/studenthandbook/index.php
Class Schedule (Tentative)

Week 1: Discuss the Structure and Purpose of the General GRE Exam, Subject GRE Exam, and discuss timelines associated with applying and taking the subject GRE Exam and how they relate to the grad school application process. Discuss general test-taking strategies. Discuss topics typically covered on subject GRE exam. General Q&A about the general and subject GRE exams and graduate school. Review of introductory Physics. First Sample GRE Test DUE!

Week 2: First Sample GRE Test Returned! Work through problems on the first sample GRE test. Show examples of questions that can be productively addressed by appeals to symmetry, limiting cases, scaling, and/or dimensional analysis. Work through questions on the first exam that the class as a whole performed poorly on. Second Sample GRE Test DUE!

Week 3: Second Sample GRE Test Returned! Work through problems on the second sample GRE test. Show examples of questions that can be productively addressed by appeals to symmetry, limiting cases, scaling, and/or dimensional analysis. Work through questions on the second exam that the class as a whole performed poorly on. Third Sample GRE Test DUE!

Week 4: Third Sample GRE Test Returned! Work through problems on the third sample GRE test. Show examples of questions that can be productively addressed by appeals to symmetry, limiting cases, scaling, and/or dimensional analysis. Work through questions on the third exam that the class as a whole performed poorly on. Fourth Sample GRE Test DUE!

Week 5: Fourth Sample GRE Test Returned! Work through problems on the fourth sample GRE test. Show examples of questions that can be productively addressed by appeals to symmetry, limiting cases, scaling, and/or dimensional analysis. Work through questions on the fourth exam that the class as a whole performed poorly on. Fifth Sample GRE Test DUE!

Week 6: Fifth Sample GRE Test Returned! Work through problems on the fifth sample GRE test. Show examples of questions that can be productively addressed by appeals to symmetry, limiting cases, scaling, and/or dimensional analysis. Work through questions on the fifth exam that the class as a whole performed poorly on. Present an introduction to Fermi problems – their general form, and instructor presentation of a few solved examples. Discuss general methods of solving Fermi problems. Prepared Fermi Topics Assigned!

Week 7 and Final Exam Time Slot: Presentation of Student-Prepared Fermi Questions and Extemporaneous Fermi Questions
November 11th, 2015

The Department of Physics & Astronomy is proposing the addition of the newly created upper-level course Physics Problem Solving (PHYS 481) as an elective within the Physics B.S. program.

This new course has been offered as a special topics several times (thus already counting as a Physics B.S. elective), and is designed to primarily serve students who are intending to enroll in Physics and Astrophysics graduate programs.

There will be no cost in adding this elective, as there will be ample space in the class for any Physics B.S. student who wishes to take the course.

Thank you for your time and consideration,

[Signature]

Michael L. Larsen
Assistant Professor of Physics and Astronomy
FACULTY CURRICULUM COMMITTEE
CHANGE/DELETE PROGRAM FORM

Instructions:
- Please fill out all of the portions of the form that are specified in section B. You must do this before your request can move forward!
- Remember that your changes will not be implemented until the next catalog year at the earliest.
- If you have questions, please start by checking the detailed instructions on the website.
- Please feel free to contact the committee chair with any remaining questions you might have.

A. CONTACT INFORMATION.

Name: Michael L. Larsen       Phone: 843-953-2128    Email: LarsenML@cofc.edu

School: SSM           Department or Program: Physics and Astronomy

Name and Acronym of Major: Physics B.S. (PHYS)

B. CATEGORY OF REVIEW. Please check all that apply, then fill out the specified parts of the form.

☒ Change Request (fill out all sections)
☐ Add an existing course to requirements or electives
☒ Add a new course to requirements or electives (attach completed course form for each)
☐ Delete courses from requirements or electives
☐ Add or modify concentration*
☐ Add or modify cognate*

*Note: Only concentrations and cognates requiring 18 or more credit hours will be tracked in Banner and Degree Works and noted on the transcript.

☐ Terminate Program (fill out E, G, H, and I)
☐ Terminate degree
☐ Terminate major
☐ Terminate concentration
☐ Terminate cognate

C. GENERAL INFORMATION

Number of Current Credit Hours (for existing program): _____58+________
Number of Proposed Credit Hours (for changed program): _____58+_______
Catalog Year in which changes will take effect: FALL 2016

D. CURRICULUM. Please list every change you are making below AND attach the current Program of Study Worksheet for this major (http://registrar.cofc.edu/program-of-study-resources/program-of-study-worksheets/index.php) with changes marked in RED. Additions should show where the course will be inserted, deletions should be noted by crossing out the course, and moves indicated with arrows. Distinguish between required and elective courses, and note any prerequisites, co-requisites, sequencing, or other restrictions. Provide the catalog description and course list exactly as they should appear in the catalog. For each new course, submit the Curriculum Committee’s Course Form and a sample syllabus.

We are adding PHYS 481 (Physics Problem Solving) as an elective.

This form was last updated on 6/6/2013 and replaces all others.
E. RATIONALE AND EXPLANATION. Please provide a narrative addressing the request you are making and why you are making it.

The new course PHYS 481 (Physics Problem Solving) is being created primarily in order to help serve our graduate-school bound majors succeed in taking the Advanced Physics GRE exam. As described in more detail in the course creating cover letter, the skills and techniques used on this exam are somewhat distinct from the skills developed in the rest of our curriculum, and we are creating this course (and adding it to our elective list) to help ensure our students have ever chance for success after graduating from CoC.

F. STUDENT LEARNING OUTCOMES AND ASSESSMENT.

<table>
<thead>
<tr>
<th>Student Learning Outcomes</th>
<th>Assessment Method and Performance Expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>What will students know and be able to do when they complete the major or program?</td>
<td>How will each outcome be measured? Who will be assessed, when, and how often? How well should students be able to do on the assessment?</td>
</tr>
<tr>
<td>1. Students will demonstrate basic conceptual understanding of topics, for example, special relativity, wave-particle duality, properties of quantum mechanical wavefunctions, and limitations of classical physics as measured in the final exam administered in PHYS 230.</td>
<td>This outcome is assessed in PHYS 230. At least 80% of the students will score 75% or higher on conceptual questions related to these topics in both the final exam and the midterm examinations for PHYS 230.</td>
</tr>
<tr>
<td>2. Students will apply their numerical and computational skills to solve complex problems involving, for example, Lagrangian mechanics, non-inertial reference frames, time evolution of a quantum state (computational), operators and commutators, spin, Maxwell’s equations, and Laplace’s equation (computational).</td>
<td>This outcome is assessed in PHYS 301, 403, and 409. At least 80% of the students will score 75% or higher on solving problems related to these topics on homework assignments and final exams administered in PHYS 301, 403, and 409.</td>
</tr>
<tr>
<td>3. Students will perform an advanced experimental project and data analysis including, for example, distinguishing statistical and systematic errors, propagating errors, and representing data graphically.</td>
<td>This outcome is assessed in PHYS 370. At least 80% of the students will score 75% or higher on a formal project and an oral presentation assessed via standard rubrics in PHYS 370.</td>
</tr>
<tr>
<td>4. Students will successfully pursue graduate education after completing BS in physics.</td>
<td>At least 50% of all student indicate that they will consider or are accepted into a graduate program during an exit survey from the program.</td>
</tr>
</tbody>
</table>

This form was last updated on 6/6/2013 and replaces all others.
Additional Outcomes or Comments:

This course, as an upper-level elective, does not have a direct role in the program assessment of the B.S. degree. However, data acquired from sample tests taken in this course may help inform and target future departmental assessment strategies.

G. IMPACT ON EXISTING PROGRAMS AND COURSES. Please describe the impact of this request on other programs and courses. If you are deleting a program, please describe the effect on all programs that will be impacted, if you are adding or changing a program, please explain any overlap with existing programs at the College.

This course should not impact any other programs or courses.

H. COSTS ASSOCIATED WITH THE REQUESTED ACTION. List all of the new costs or cost savings (including new faculty/staff requests, library, or equipment) associated with your request.

Since this course already exists and has been taught as a special topics for some time, there are no new costs associated with this change.

I. CHECKLIST

☒ I have completed all relevant parts of the form.

☒ I have attached a cover letter that describes my request and lists all the documents I am submitting.

☒ I have attached a Course Form for each newly-created or modified course.

☐ (For proposals that affect other departments in any way) I have attached an acknowledgement from the relevant department.

☒ I have provided the complete curriculum for the program, concentration, emphasis, etc., including the description and course list, exactly as it should appear in the catalog.

☒ I have submitted one Signature Form that lists all of the different forms I am submitting.

This form was last updated on 6/6/2013 and replaces all others.
Physics Major Requirements
Catalog Year: 2015-16
Degree: Bachelor of Science
Physics Major Credit Hours: 58+

"PR" indicates a pre-requisite. "CO" indicates a co-requisite.

Courses within this major may also satisfy general education requirements. Please consult http://registrar.cofc.edu/general-edu for more information.

Required Courses

- PHYS 111 General Physics I (3) PR or CO: MATH 120 or equivalent or instructor permission; CO: PHYS 111L
- PHYS 111L General Physics I Lab (1) CO: PHYS 111
- PHYS 112* General Physics II (3) PR: PHYS 111 or HONS 157; CO or PR: MATH 220 or equivalent or instructor permission; CO: PHYS 112L
- PHYS 112L General Physics II Lab (1) CO: PHYS 112
- PHYS 230 Introduction to Modern Physics I (3) PR: PHYS 112 or HONS 158; CO or PR: MATH 211 or instructor permission
- PHYS 301 Classical Mechanics (3) PR: PHYS 112 or HONS 158 and MATH 323 or PHYS 272 or permission of instructor
- PHYS 370 Experimental Physics (4) PR: PHYS 230 or instructor permission
- PHYS 403 Introductory Quantum Mechanics (3) PR: PHYS 230 and MATH 323 or PHYS 272, or Instructor permission
- PHYS 409 Electricity and Magnetism (3) PR: PHYS 112 or HONS 158 and MATH 323 or PHYS 272 or permission of instructor
- PHYS 419 Research Seminar (1) PR or CO: PHYS 370 or ASTR 377 or instructor and department chair permission
- PHYS 420** Senior Research (3) PR: PHYS 419 and instructor and department chair permission
- PHYS 499** Bachelor's Essay (1-6) PR: PHYS 419 or department chair permission. Credit will not be awarded for both PHYS 420 and PHYS 499

Notes: * Upon completion of PHYS 101 with a grade of B or better and successful completion of MATH 120, a student may transfer to PHYS 112. **Credit will not be awarded for both PHYS 420 and PHYS 499.

- Select 15 credit hours from the following electives with department approval. Please note a maximum of 6 credit hours are allowed from PHYS 381, 390 and 399.

- ASTR 306 Planetary Astronomy (3) PR: ASTR 231
- ASTR 311 Stellar Astronomy and Astrophysics (3) PR: ASTR 231 and MATH 221
- ASTR 312 Galactic and Extragalactic Astronomy (3) PR: ASTR 231 and MATH 221
- ASTR 377 Experimental Astronomy (4) PR: ASTR 231
- ASTR 410 Black Holes: Advanced Topics (1) PR: PHYS 112, PHYS 112L or instructor permission; PR or CO: ASTR 210
- ASTR 413 Astrophysics (3) PR: PHYS 301 and MATH 323 or instructor permission
- ASTR 460L NASA Space Mission Design Leadership Lab (1) PR: Instructor permission; PR or CO: ASTR 260
- PHYS 302 Classical Mechanics (3) PR: PHYS 301
- PHYS 308 Atmospheric Physics (3) PR: PHYS 112, PHYS 112L or HONS 158 or instructor permission
- PHYS 320 Intro to Electronics (4) PR: PHYS 102 and MATH 120 or PHYS 112 or HONS 158 or instructor permission
PHYS 331  Intro to Modern Physics II (3) PR: PHYS 230
PHYS 340  Photonics (4) PR: PHYS 112, PHYS 112L or HONS 158
PHYS 350  Energy Production (4) PR: CHEM 111, CHEM 111L (PHYS 112, 112L or HONS 158) or (PHYS 102, 102L and MATH 120)
PHYS 381  Internship (1-4) PR: Declared PHYS major, PHYS 370, and coordinator permission
PHYS 390  Research (1-3; repeatable up to 6) PR: Department chair and instructor permission
PHYS 394  Digital Signal and Image Processing with Biomedical Applications (3) PR: PHYS 112 and 112L or HONS 158 and 158L; CO: PHYS 394L
PHYS 394L Digital Signal and Image Processing with Biomedical Applications Laboratory (1) PR: PHYS 112 and 112L or HONS 158 and 158L; CO: PHYS 394
PHYS 396  Biophysics Model and Excitable Cells (3) PR: BIOL 111 or HONS 151 and PHYS 112 or HONS 158 or permission of instructor
PHYS 397  Research Experience Physics and Astronomy (0) PR: Only declared majors can take a Zero Credit Research course. Instructor and department chair permission required.
PHYS 399  Tutorial (3; repeatable up to 12) PR: Junior standing and department chair and instructor permission
PHYS 405  Thermal Physics (3) PR: PHYS 230 and MATH 323 or PHYS 272, or instructor permission
PHYS 407  Introduction to Nuclear Physics (3) PR: PHYS 230 or instructor permission
PHYS 408  Introduction to Solid State Physics (3) PR: PHYS 230 and MATH 323 or PHYS 272, or instructor permission
PHYS 410  Electricity and Magnetism (3) PR: PHYS 409
PHYS 412  Special Topics (1-3) PR: Instructor permission
PHYS 415  Fluid Mechanics (3) PR: MATH 323 and PHYS 301 or instructor permission
PHYS 456  Air Pollution Meteorology (4) PR: PHYS 112, PHYS 112L or (PHYS 102, PHYS 102L and MATH 120) or HONS 158, CHEM 112, CHEM 112L or instructor permission
PHYS 457  Satellite Meteorology (3) PR: PHYS 308 or PHYS 456 or (PHYS 105 and PHYS 112, PHYS 112L) or (PHYS 105 and PHYS 102, PHYS 102L and MATH 120) or (PHYS 105 and HONS 158)
PHYS 458  Climate Change (4) PR: PHYS 112, PHYS 112L or HONS 158
PHYS 460L NASA Space Mission Design Leadership Lab (1) PR: Instructor permission; CO: PHYS 260
PHYS 481 Physics Problem Solving (1) PR or CO: PHYS 370 or ASTR 377

Mathematics Requirement:

☐ MATH 120 Introductory Calculus (4) PR: Placement or C- or better in MATH 111
☐ MATH 220 Calculus II (4) PR: MATH 120 or HONS 115
☐ MATH 221 Calculus III (4) PR: MATH 220 or equivalent
☐ MATH 323 Differential Equations (3) PR: MATH 221 and MATH 203 or equivalent or permission of instructor

Optional: Students may also select a concentration in Computational Neuroscience, Energy Production or Meteorology.

Notes:
• With department approval, completion with grades of at least "B" in PHYS 101/101L and PHYS 102/102L, together with MATH 120 and MATH 220 may be substituted for PHYS 111/111L and PHYS 112/112L.

• Suggested programs of study leading to graduate school in physics, astronomy, astrophysics, meteorology and engineering are available from the department.
The Department of Physics & Astronomy is proposing the addition of the newly created upper-level course Physics Problem Solving (PHYS 481) as an elective within the Physics B.A. program.

This new course has been offered as a special topics course several times (thus already counting as a Physics B.A. elective). Though most BA students likely would not opt to take this course as an elective, there is a subset of Physics B.A. students (notably science education students) who could benefit greatly from receiving formal training on the test-solving techniques utilized in this course.

There will be no cost in adding this elective, as there will be ample space in the class for any Physics B.A. student who wishes to take the course.

Thank you for your time and consideration,

[Signature]

Michael L. Larsen
Assistant Professor of Physics and Astronomy
FACULTY CURRICULUM COMMITTEE
CHANGE/DELETE PROGRAM FORM

Instructions:
- Please fill out all of the portions of the form that are specified in section B. You must do this before your request can move forward!
- Remember that your changes will not be implemented until the next catalog year at the earliest.
- If you have questions, please start by checking the detailed instructions on the website.
- Please feel free to contact the committee chair with any remaining questions you might have.

A. CONTACT INFORMATION.

Name: Michael L. Larsen Phone: 843-953-2128 Email: LarsenML@cofc.edu
School: SSM Department or Program: Physics and Astronomy
Name and Acronym of Major: Physics B.A. (PHYS)

B. CATEGORY OF REVIEW. Please check all that apply, then fill out the specified parts of the form.

☐ Change Request (fill out all sections)
  ☐ Add an existing course to requirements or electives
  ☑ Add a new course to requirements or electives (attach completed course form for each)
  ☐ Delete courses from requirements or electives
  ☐ Add or modify concentration*
  ☐ Add or modify cognate*

*Note: Only concentrations and cognates requiring 18 or more credit hours will be tracked in Banner and Degree Works and noted on the transcript.

☐ Terminate Program (fill out E, G, H, and I)
  ☐ Terminate degree
  ☐ Terminate major
  ☐ Terminate concentration
  ☐ Terminate cognate

C. GENERAL INFORMATION

Number of Current Credit Hours (for existing program): _______42+_______
Number of Proposed Credit Hours (for changed program): _______42+_______
Catalog Year in which changes will take effect: FALL _______2016________

D. CURRICULUM. Please list every change you are making below AND attach the current Program of Study Worksheet for this major (http://registrar.cofc.edu/program-of-study-resources/program-of-study-worksheets/index.php) with changes marked in RED. Additions should show where the course will be inserted, deletions should be noted by crossing out the course, and moves indicated with arrows. Distinguish between required and elective courses, and note any prerequisites, co-requisites, sequencing, or other restrictions. Provide the catalog description and course list exactly as they should appear in the catalog. For each new course, submit the Curriculum Committee's Course Form and a sample syllabus.

We are adding PHYS 481 (Physics Problem Solving) as an elective.

This form was last updated on 6/6/2013 and replaces all others.  

Page 1 of 3
E. RATIONALE AND EXPLANATION. Please provide a narrative addressing the request you are making and why you are making it.

The new course PHYS 481 (Physics Problem Solving) is being created primarily in order to help serve our majors succeed in taking the Advanced Physics GRE exam. As described in more detail in the course creation cover letter, the skills and techniques used on this exam are somewhat distinct from the skills developed in the rest of our curriculum, and we are creating this course (and adding it to our elective list) to help ensure our students have every chance for success after graduating from CoFC.

F. STUDENT LEARNING OUTCOMES AND ASSESSMENT.

<table>
<thead>
<tr>
<th>Student Learning Outcomes</th>
<th>Assessment Method and Performance Expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>What will students know and be able to do when they complete the major or program?</td>
<td>How will each outcome be measured? Who will be assessed, when, and how often? How well should students be able to do on the assessment?</td>
</tr>
<tr>
<td>1. Students will demonstrate basic conceptual understanding of topics, for example, special relativity, wave-particle duality, properties of quantum mechanical wavefunctions, and limitations of classical physics as measured in the final exam administered in PHYS 230.</td>
<td>This outcome is assessed in PHYS 230. At least 80% of the students will score 75% or higher on conceptual questions related to these topics in both the final exam and the midterm examinations for PHYS 230.</td>
</tr>
<tr>
<td>2. Students will apply their numerical and computational skills to solve problems involving, for example, electricity, waves, optics, and spectroscopy.</td>
<td>This outcome is assessed in PHYS 203, 270, 320, 340, and 396. At least 80% of students will score 75% or higher on problem solving associated with these topics in both homework assignments and final exams in PHYS 203, 270, 320, 340, and 396.</td>
</tr>
<tr>
<td>3. Students will perform an advanced experimental project and data analysis including, for example, distinguishing statistical and systematic errors, propagating errors, and representing data graphically.</td>
<td>This outcome is assessed in PHYS 370. At least 80% of the students will score 75% or higher on a formal project and an oral presentation assessed via standard rubrics in PHYS 370.</td>
</tr>
<tr>
<td>4. Students will successfully pursue a career in medicine, teaching, and/or some other field (specific to BA)</td>
<td>This outcome assessed in a graduate survey administered immediately after graduation and during an exit interview.</td>
</tr>
</tbody>
</table>
Additional Outcomes or Comments:

This course, as an upper-level elective, does not have a direct role in the program assessment of the B.A. degree. However, data acquired from sample tests taken in this course may help inform and target future departmental assessment strategies.

G. IMPACT ON EXISTING PROGRAMS AND COURSES. Please describe the impact of this request on other programs and courses. If you are deleting a program, please describe the effect on all programs that will be impacted; if you are adding or changing a program, please explain any overlap with existing programs at the College.

This course should not impact any other programs or courses.

H. COSTS ASSOCIATED WITH THE REQUESTED ACTION. List all of the new costs or cost savings (including new faculty/staff requests, library, or equipment) associated with your request.

Since this course already exists and has been taught as a special topics for some time, there are no new costs associated with this change.

I. CHECKLIST

☑ I have completed all relevant parts of the form.

☑ I have attached a cover letter that describes my request and lists all the documents I am submitting.

☑ I have attached a Course Form for each newly-created or modified course.

☐ (For proposals that affect other departments in any way) I have attached an acknowledgement from the relevant department.

☑ I have provided the complete curriculum for the program, concentration, emphasis, etc., including the description and course list, exactly as it should appear in the catalog.

☑ I have submitted one Signature Form that lists all of the different forms I am submitting.
Physics Major Requirements
Catalog Year: 2015-16
Degree: Bachelor of Arts
Physics Major Credit Hours: 42+

"PR" indicates a pre-requisite. "CO" indicates a co-requisite.

Courses within this major may also satisfy general education requirements. Please consult http://registrar.cofc.edu/general-edu for more information.

Required Courses

☐ PHYS 111  General Physics I (3) PR or CO: MATH 120 or equivalent or instructor permission; CO: PHYS 111L
☐ PHYS 111L General Physics I Lab (1) CO: PHYS 111

☐ PHYS 112* General Physics II (3) PR: PHYS 111 or HONS 157; CO or PR: MATH 220 or equivalent or instructor permission; CO: PHYS 112L
☐ PHYS 112L General Physics II Lab (1) CO: PHYS 112

☐ PHYS 230 Introduction to Modern Physics I (3) PR: PHYS 112 or HONS 158; CO or PR: MATH 211 or instructor permission

☐ PHYS 370 Experimental Physics (4) PR: PHYS 230 or instructor permission

☐ PHYS 419 Research Seminar (1) PR or CO: PHYS 370 or ASIR 377 or instructor and department chair permission

☐ PHYS 420** Senior Research (3) PR: PHYS 419 and instructor and department chair permission
OR
☐ PHYS 499** Bachelor’s Essay (1-6) PR: PHYS 419 or department chair permission. Credit will not be awarded for both PHYS 420 and PHYS 499

Notes: * Upon completion of PHYS 101 with a grade of B or better and successful completion of MATH 120, a student may transfer to PHYS 112. **Credit will not be awarded for both PHYS 420 and PHYS 499.

☐ Select 11 credit hours from the following electives with department approval. Please note a maximum of 3 credit hours from each of the following groups are allowed (PHYS 381, PHYS 390 and PHYS 399) and (PHYS 260, PHYS 260L, PHYS 460L).

Physics Electives List

PHYS 203 Physics and Medicine (3) PR: PHYS 102, PHYS 102L or PHYS 112, PHYS 112L or HONS 158

PHYS 260 NASA Space Mission Design (2) PR: ASTR 130 or ASTR 306 or HONS 160 or GEOL 206 or PHYS 102 or PHYS 112 or HONS 158 or instructor permission; CO: PHYS 260L or 460 L

PHYS 260L NASA Space Mission Design Laboratory (1) CO: PHYS 260

PHYS 298 Special Topics (1-3) PR: Instructor permission

PHYS 301 Classical Mechanics (3) PR: PHYS 112 or HONS 158 and MATH 323 or PHYS 272 or permission of instructor

PHYS 302 Classical Mechanics (3) PR: PHYS 301

PHYS 308 Atmospheric Physics (3) PR: PHYS 112, PHYS 112L or HONS 158 or instructor permission

PHYS 320 Intro to Electronics (4) PR: PHYS 102 and MATH 120 or PHYS 112 or HONS 158 or instructor permission

PHYS 331 Intro to Modern Physics II (3) PR: PHYS 230
PHYS 340  Photonics (4) PR: PHYS 112, PHYS 112L or HONS 158

PHYS 350  Energy Production (4) PR: CHEM 111, CHEM 111L (PHYS 112, 112L or HONS 158) or (PHYS 102, 102L and MATH 120)

PHYS 381  Internship (1-4) PR: Coordinator and department chair permission

PHYS 390  Research (1-3; repeatable up to 6) PR: Department chair and instructor permission

PHYS 394  Digital Signal and Image Processing with Biomedical Applications (3) PR: PHYS 112 and 112L or HONS 158 and 158L; CO: PHYS 394L

PHYS 394L  Digital Signal and Image Processing with Biomedical Applications Laboratory (1) PR: PHYS 112 and 112L or HONS 158 and 158L; CO: PHYS 394

PHYS 396  Biophysics Model and Excitable Cells (3) PR: BIOL 111 or HONS 151 and PHYS 112 or HONS 158 or permission of instructor

PHYS 397  Research Experience Physics and Astronomy (0) PR: Only declared majors can take a Zero Credit Research course. Instructor and department chair permission required.

PHYS 399  Tutorial (3; repeatable up to 12) PR: Junior standing and department chair and instructor permission

PHYS 403  Introductory Quantum Mechanics (3) PR: PHYS 230 and MATH 323 or PHYS 272, or instructor permission

PHYS 405  Thermal Physics (3) PR: PHYS 230 and MATH 323 or PHYS 272, or instructor permission

PHYS 407  Introduction to Nuclear Physics (3) PR: PHYS 230 or instructor permission

PHYS 408  Introduction to Solid State Physics (3) PR: PHYS 230 and MATH 323 or PHYS 272, or instructor permission

PHYS 409  Electricity and Magnetism (3) PR: PHYS 112 or HONS 158 and MATH 323 or PHYS 272 or permission of instructor

PHYS 410  Electricity and Magnetism (3) PR: PHYS 409

PHYS 412  Special Topics (1-3) PR: Instructor permission

PHYS 415  Fluid Mechanics (3) PR: MATH 323 and PHYS 301 or instructor permission

PHYS 456  Air Pollution Meteorology (4) PR: PHYS 112, PHYS 112L or (PHYS 102, PHYS 102L and MATH 120) or HONS 158; CHEM 112, CHEM 112L or instructor permission

PHYS 457  Satellite Meteorology (3) PR: PHYS 308 or PHYS 456 or (PHYS 105 and PHYS 112, PHYS 112L) or (PHYS 105 and PHYS 102, PHYS 102L and MATH 120) or (PHYS 105 and HONS 158)

PHYS 458  Climate Change (4) PR: PHYS 112, PHYS 112L or HONS 158

Biology Requirement

PHYS 460L  NASA Space Mission Design Leadership Lab (1) PR: Instructor permission; CO: PHYS 260

PHYS 481  Physics Problem Solving (1) PR or CO: PHYS 370 or ASTR 377

Mathematics Requirement

☐ MATH 120  Introductory Calculus (4) PR: Placement or C- or better in MATH 111

☐ MATH 220  Calculus II (4) PR: MATH 120 or HONS 115

☐ MATH 221  Calculus III (4) PR: MATH 220 or equivalent
Optional: Students may also select a concentration in Computational Neuroscience, Energy Production or Meteorology.

Notes:

- With department approval, completion with grades of at least "B" in PHYS 101/101L and PHYS 102/102L, together with MATH 120 and MATH 220 may be substituted for PHYS 111/111L and PHYS 112/112L.

- Suggested programs of study leading to graduate school in physics, astronomy, astrophysics, meteorology and engineering are available from the department.
FACULTY CURRICULUM COMMITTEE
SIGNATURE PAGE

- In section A, list ALL of the forms covered by this signature page. If you submit a form that is not listed in A, your proposal will be held back until we receive a new, updated signature page.
- You must obtain the signature of your department chair and dean before submitting your proposal.

A. FORMS COVERED BY THIS SIGNATURE PAGE. List each form you are submitting—for instance, PSYC 383, Course Form; PSYC, Change of Major Form; PSYC, Change of Minor Form.

PHYS 481 Course Form
PHYS BS Change of Major Form
PHYS BA Change of Major Form

B. APPROVAL AND SIGNATURES.

1. Signature of Department Chair or Program Director:

   Narayan Kathirvel
   Date: 12/12/2015

2. Signature of Academic Dean:

   [Signature]
   Date: 12/15/2015

3. Signature of Provost:

   [Signature]
   Date: 1/6/16

4. Signature of Business Affairs (only for course fees):

   [Signature]
   Date: ________________
   □ fee approved on ________________
   □ BOT approval pending

5. Signature of Curriculum Committee Chair:

   [Signature]
   Date: ________________

6. Signature of Budget Committee Chair (only for new programs):

   [Signature]
   Date: ________________

7. Signature of Academic Planning Committee Chair (only for new programs):

   [Signature]
   Date: ________________

8. Signature of Faculty Senate Secretary:

   [Signature]
   Date: ________________

Date Approved by Faculty Senate: ________________