CAS/GRS New Course Proposal Form
This form is to be used when proposing a new CAS or GRS course.

This form should be submitted to Senior Academic Administrator Peter Law (617-353-7243) as a PDF file to pgl@bu.edu. For further information or assistance, contact Associate Dean Susan Jackson (617-353-2410; sjackson@bu.edu) about CAS courses or Associate Dean Jeffrey Hughes (617-353-2690; hughes@bu.edu) about GRS courses.

DEPARTMENT OR PROGRAM: Earth & Environment, Biology, BU Marine Program (BUMP)
DATE SUBMITTED: Dec 19, 2016

COURSE NUMBER: CAS ES 591 / CAS BI 591

COURSE TITLE: Bio-Optical Oceanography

INSTRUCTOR(S): Fichot

TO BE FIRST OFFERED: Sem./Year: __Fall__/___2017___

SHORT TITLE: The “short title” appears in the course inventory, on the Link University Class Schedule, and on student transcripts and must be 15 characters maximum including spaces. It should be as clear as possible.

COURSE DESCRIPTION: This is the description that appears in the CAS and/or GRS Bulletin and is the first guide that students have as to what the course is about. The description can contain no more than 40 words.

This field- and lab-based course explores how the optically active constituents in seawater affect the in-water light field, and in turn, how field optics and remote sensing can facilitate the study of marine biogeochemistry, biological oceanography and water quality.

PREREQUISITES: Indicate “None” or list all elements of the prerequisites, clearly indicating “AND” or “OR” where appropriate. Here are three examples: “Junior standing or CAS ZN300 or consent of instructor”; “CAS ZN108 and CAS ZN203 and CAS PQ206; or consent of instructor”; “For SED students only.”

1. State the prerequisites:
   • CH 101, or CH 109, or CH 171
   • MA 121 or MA 123
   • MA 122 or MA 124 is recommended but optional
   • ES 144 (or equivalents) or permission of instructor
   • Admission to the Marine Semester

2. Explain the need for these prerequisites:
   Students should have a basic understanding of chemistry, calculus, and oceanography.
CREDITS:  (check one)

☐ Half course: 2 credits  ☐ Variable: Please describe.
☒ Full course: 4 credits  ☐ Other: Please describe.

Provide a rationale for this number of credits, bearing in mind that for a CAS or GRS course to carry 4 credits, 1) it must normally be scheduled to meet at least 150 minutes/week, AND 2) combined instruction and assignments, as detailed in the attached course syllabus, must anticipate at least 12 total hours/week of student effort to achieve course objectives.

The proposed course will be part of the BUMP marine semester and will be taught over the course of 4 weeks during the second block of the semester (October). The course will include a balanced combination of lectures, field work, laboratory work (analyses and experiments), data analysis, satellite imagery analysis, oral presentations, and scientific writing. Students will be fully dedicated to the course during the 4-week period.

DIVISIONAL STUDIES CREDIT: Is this course intended to fulfill Divisional Studies requirements?

☒ No
☐ Yes. If yes, please indicate which division ______________________ and explain why the course should qualify for Divisional Studies credit. Refer to criteria listed here and specify whether this course is intended for “short” or “expanded” divisional list.

HOW FREQUENTLY WILL THE COURSE BE OFFERED?

☐ Every semester  ☐ Once a year, fall  ☐ Once a year, spring  ☐ Every other year, Fall  ☒ Other: Explain:

NEED FOR THE COURSE: Explain the need for the course and its intended impact. How will it strengthen your overall curriculum? Will it be required or fulfill a requirement for degrees/majors/minors offered by your department/program or for degrees in other departments/school/colleges? Which students are most likely to be served by this course? How will it contribute to program learning outcomes for those students? If you see the course as being of “possible” or “likely” interest to students in another departments/program, please consult directly with colleagues in that unit. (You must attach appropriate cognate comments using cognate comment form if this course is intended to serve students in specific other programs. See FURTHER INFORMATION below about cognate comment.)

The proposed ES/BI 591 course will be a new elective course available to undergraduate students enrolled in the BU Marine Semester, and to any graduate students. This course will merge elements of optics and remote sensing with elements of marine science and biogeoscience and will therefore also represent an attractive new elective for students across disciplines. This new course represents a step toward increasing the multi-disciplinary nature of the BU marine program and will expand the choice of courses available in the BU marine semester. The new course is also expected to benefit the curriculum in the following ways:

1. By providing experiential training in marine optics and additional opportunities for students to get a comprehensive and well-rounded education in marine science.
2. By reinforcing the oceanography component of the BU marine program.
3. By helping recruit undergraduate students from other disciplines into the BU marine semester.
4. By helping increase the enrollment of graduate students, primarily from Biology and Earth and Environment and those interested in remote sensing.
5. By providing a research-oriented, field- and laboratory-based follow-up or complement to the new course ES420/620 ("Aquatic Optics and Remote Sensing") to be taught every Spring by Dr. Fichot.
6. By developing students’ abilities to do field and laboratory work as a team.
7. By helping students acquire important transferrable skills such as formulating research questions, data analysis, critical thinking, and written and oral communication, or adapting to change.
8. The course will be conducted in partnership with the Stellwagen Bank National Marine Sanctuary and will therefore continue to reinforce the thriving relationship between BU and the sanctuary.

ENROLLMENT: How many undergraduate and/or graduate students do you expect to enroll in the initial offering of this course?

A total of 8-12 students. At least 6 students are expected to be upper-level undergraduates enrolled in the BU Marine Semester, and the rest is expected to be made of Ph.D. students from Earth & Environment or Biology.

CROSS-LISTING: Is this course to be cross-listed or taught with another course? If so, specify. Chairs/directors of all cross-listing units must co-sign this proposal on the signature line below.

N/A

OVERLAP:

1. Are there courses in the Course Inventory (CC00) with the same number and/or title as this course
   - No.
   - Yes. If yes, any active course(s) with the same number or title as the proposed course will be phased out upon approval of this proposal.
2. Relationship to other courses in your program or others: Is there any significant overlap between this course and others offered by your department/program or by others? (You must attach appropriate cognate comments using cognate comment form if this course might be perceived as overlapping with courses in another department/program. See FURTHER INFORMATION below.)

There is no overlap in the content of this course with other courses currently offered in Earth and Environment or other departments.

FACILITIES AND EQUIPMENT: What, if any, are the new or special facilities or equipment needs of the course (e.g., laboratory, library, instructional technology, consumables)? Are currently available facilities, equipment, and other resources adequate for the proposed course? (NOTE: Approval of proposed course does not imply commitment to new resources to support the course on the part of CAS.)

This course will make use of resources from the BU marine program, the BU Department of Earth and Environment, and the NOAA Stellwagen National Marine Sanctuary.

BU Marine Program:
- BUMP will provide van rental for transport to Scituate, MA
- Field equipment (CTD rosette/instruments)

Department of Earth and Environment:
The Aquatic Photo-biogeochemistry and Remote Sensing Laboratory (Dr. Fichot) will be used for sample preparation and laboratory analyses associated with the course.

Departmental computing facilities (Room 435 of the Department of Earth and Environment) and the Matlab® software will be used for the remote sensing data analysis portion of the course (when the room is available).

Conference room will be used for lectures, presentations, and paper discussions.

NOAA Stellwagen National Marine Sanctuary:

- The R/V Auk operated by the Marine sanctuary will be used for 4 or 5 different full-day operations.
- Projector rooms at the sanctuary headquarters will be used occasionally for lectures and final presentations.

STAFFING: How will the staffing of this course, in terms of faculty and, where relevant, teaching fellows, affect staffing support for other courses? For example, are there other courses that will not be taught as often as now? Is the staffing of this course the result of recent or expected expansion of faculty? (NOTE: Approval of proposed course does not imply commitment to new resources to support the course on the part of CAS.)

This course will be taught by a new hire in the EE department (Fichot) and will not adversely affect net departmental course staffing. The course will be taught every other year (starting in 2017) in place of the existing course “ES557 Oceanography at Stellwagen Bank” currently taught by an instructor outside BU.

BUDGET AND COST: What, if any, are the other new budgetary needs or implications related to the start-up or continued offering of this course? If start-up or continuation of the course will entail costs not already discussed, identify them and how you expect to cover them. (NOTE: Approval of proposed course does not imply commitment to new resources to support the course on the part of CAS.)

Note the budget detailed below will be covered by the BU Marine Program.

Transportation: The class will require the use of 1 or 2 vans to transport students and field equipment between BU and the NOAA Stellwagen Bank National Sanctuary headquarters in Scituate, MA.

Day use of NOAA’s Auk Research Vessel: The Auk will be used 4 or 5 times for full-day during the duration of the course.

Laboratory work: Equipment and facilities from the Aquatic Photo-biogeochemistry and Remote Sensing laboratory (The Fichot Lab) and will be used for sample preparation and analysis and for field work. The equipment present in the lab will be purchased using Dr. Fichot’s start-up funds and research grants, but some money will be required for equipment maintenance/calibration and for purchasing supplies.

Request for new piece of equipment: A new optical backscattering sensor is also requested as a one-time purchase because it is a fundamental measurement used in bio-optical oceanography and it is needed for the course, and it will complement the existing set of oceanographic measurements made from the NOAA R/V Auk.

Details about the budget are provided in the table below.
### Recurrent Annual Cost ($)

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ship-time onboard NOA R/V Auk</td>
<td>Research vessel will be used for 4-5 full-day trips</td>
<td>2,000/day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub-total</td>
</tr>
<tr>
<td>Laboratory and Field Supplies Equipment</td>
<td>Onboard and lab-based filtrations</td>
<td>1,500</td>
</tr>
<tr>
<td></td>
<td>Laboratory organic carbon analyses (TOC and CHN analyses)</td>
<td>1,500</td>
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<tr>
<td></td>
<td>Optical instrument calibration</td>
<td>3,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub-total</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
</tr>
</tbody>
</table>

**EXTERNAL PROGRAMS:** If this course is being offered at an external program/campus, please provide a brief description of that program and attach a CV for the proposed instructor.

*Not offered externally*

**FURTHER INFORMATION THAT MUST BE ATTACHED IN ORDER FOR THIS PROPOSAL TO BE CONSIDERED:**

A complete week-by-week SYLLABUS with student learning objectives, readings, and assignments that reflects the specifications of the course described in this proposal; that is, appropriate level, credits, etc. (See guidelines on “Writing a Syllabus” on the Center for Excellence & Innovation in Teaching [website](#).) Be sure that syllabus includes your expectations for academic honesty, with URL for pertinent [undergraduate](#) or [GRS](#) academic conduct code(s).

Cognate comment from chairs or directors of relevant departments and/or programs. Use the form [here](#) under “Curriculum Review & Modification.” You can consult with Susan Jackson (CAS) or Jeffrey Hughes (GRS) to determine which departments or programs inside and outside of CAS would be appropriate.

**DEPARTMENT CONTACT NAME AND POSITION:** David Marchant, Dept Chair

**DEPARTMENT CONTACT EMAIL AND PHONE:** MARCHANT@BU.EDU 617-353-3236

**DEPARTMENT APPROVAL:** ___________________________ 12/20/16

Department Chair

_________________________ 12/20/16

Other Department Chair(s) (for cross-listed courses) Date
CAS/GRS CURRICULUM COMMITTEE APPROVAL:

☐ Approved  Date:____________________
☐ Tabled   Date:____________________
☐ Not Approved  Date:____________________

Divisional Studies Credit:

☐ Endorsed
☐ HU
☐ MCS
☐ NS
☐ SS
☐ Not endorsed

______________________________________________________________
Curriculum Committee Chair Signature and Date

Comments:

PROVISIONAL APPROVAL REQUESTED for Semester/Year ____________________________

______________________________________________________________
Dean of Arts & Sciences Signature and Date

Comments:

CAS FACULTY:  Faculty Meeting Date: __________________  ☐ Approved  ☐ Not Approved

______________________________________________________________
Curriculum Administrator Signature and Date

Comments:
Course Overview

Light is crucial to the ecology and biogeochemical cycling of the upper ocean. Characterization of the temporal and spatial variability of light in the sea is fundamental to understanding and quantifying many optical, physical, biological, and chemical oceanographic processes. This course will explore how the various optically active constituents of marine waters (e.g., phytoplankton, suspended particles and sediments, organic matter, etc.) affect the in-water light field and optical properties of the water column. It will also explore how optical measurements made in situ or remotely (ocean color remote sensing) can facilitate the study of biogeochemistry, biology, and water quality of estuarine and marine environments.
This research-based course will be taught in October as part of the Marine Semester and is heavily based on field and laboratory work. Field work will be carried out onboard the NOAA research vessel Auk and will focus on local contrasting coastal areas including Boston Harbor, Massachusetts Bay, and Stellwagen Bank National Marine Sanctuary.

The course is intended for upper-level undergraduate and graduate students interested in coastal oceanography and biogeochemistry, optics and remote sensing.

Through this course, you can expect to gain:

- An understanding of the importance and nature of light in the ocean
- An understanding of the utility of optics to study marine biogeochemistry and biology
- Field experience doing oceanographic work and sampling onboard a research vessel
- Experience carrying out analyses (optical and chemical) and experiments in the laboratory
- Experience with accessing, processing, and utilizing ocean color remote sensing data
- Improve oral and writing communication skills

**Prerequisites**

- CH 101, or CH 109, or CH 171
- MA 121 or MA 123
- MA 122 or MA 124 is recommended but optional
- ES 144 (or equivalents) or permission of instructor
- Admission to the Marine Semester

**Course elements**

The course includes a balanced combination of lectures, field work, laboratory work (analyses and experiments), data analysis, satellite imagery analysis, oral presentations, and scientific writing.

**Lectures**

A number of lectures will be given throughout the course by the professor in order to familiarize the students with the fundamentals of bio-optical oceanography and ocean color remote sensing. Short lectures will also be given on how to do effective oral presentations and for efficient scientific writing.

**Field Work**

Field work for this course will be done in close collaboration with NOAA’s Stellwagen Bank National Marine Sanctuary (SBNMS), located in Scituate, MA. Field work will be carried out on day-long cruises onboard the NOAA’s R/V Auk and will focus on local but contrasting coastal areas in terms of their optical and biogeochemical characteristics. It will involve the use of traditional oceanographic equipment (e.g., CTD, rosette), water sampling and onboard processing (e.g., filtering), and the deployment and use of field optical instruments to characterize the in-water light field. Students should expect to go out at sea 4 or 5 times during the entire course.

**Laboratory work**
Samples collected from the boat will be brought back to the Fichot lab and analyzed for optical properties and biological and biogeochemical variables (e.g., particulate and dissolved organic carbon, chlorophyll-a). Photochemical experiments will also be conducted in the laboratory using a solar simulator.

### Satellite image analysis

Students will be introduced to the use of ocean color satellite imagery analysis and the NASA software SeaDAS ([http://seadas.gsfc.nasa.gov](http://seadas.gsfc.nasa.gov)). Students will learn how to access, use, and interpret satellite ocean color data and will be able to link these satellite data to the data collected in the field and laboratory.

### Research project

The students will work in groups to analyze, compile, and interpret all the data acquired in the field, in laboratory, from remote sensing. Each group will be required to present and discuss the results in a 20-30-min presentation. Each student will also be required to present and discuss their results in a short science manuscript. The professor and TF will provide guidance on how to effectively do an oral presentation, and organize, present and discuss results in a concise manuscript.

### Paper presentation and discussion

During the course, students will be divided in groups. Each group will be required to read a published manuscript (selected by the professor), do a short (10-15 min) oral presentation summarizing the important findings of the paper, and lead a class discussion on the topic. The entire class will be required to read the manuscript and will participate in the discussion.

### Final Exam

A final exam will be given during the last week and will test your understanding of the fundamentals of bio-optical oceanography acquired during the class.

### Course Schedule

The first few days will aim to familiarize students with some fundamentals of marine optics, ocean color remote sensing, coastal oceanography, and with the lab and boat operations that will be carried out the following weeks. The first week will also be used to identify important scientific questions and objectives and to define the field sampling strategy for the coming weeks. The two middle weeks will focus on data collection and analysis. Students should be flexible in their expectations because the field data collection depend strongly on weather. During the last week, the students will spend time working on their research projects and presentations, and manuscript and will be taking the final exam.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Week 1</th>
<th>Week 2-3</th>
</tr>
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<tbody>
<tr>
<td>Introduction to marine optics and ocean color remote sensing</td>
<td><strong>Field work and sampling onboard the R/V Auk</strong>&lt;br&gt;<strong>Laboratory work in Fichot Lab</strong>&lt;br&gt;<strong>Data compilation and analysis</strong></td>
<td>Define project objectives and design sampling strategy&lt;br&gt;Overview of lab and boat operations</td>
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Week 4

**Hands-on remote sensing training in computer lab**

**Project wrap-up and presentations**

**Final exam**

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**Grading**

Students will be evaluated based on their performance in the field and in the laboratory, on the quality of the data produced, and on the content and quality of their manuscript and oral presentation. Students will also be evaluated based on a final exam during the last week of the course. *No late work will be accepted.***

**Summary**

- Fieldwork performance: 25%
- Laboratory work performance: 25%
- Paper oral presentation and discussion: 10%
- Final exam: 10%
- Final research project
  - Manuscript: 20%
  - Oral presentation: 10%

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Letter</th>
<th>GPA</th>
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<tbody>
<tr>
<td>93-100</td>
<td>A</td>
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<tr>
<td>90-93</td>
<td>A-</td>
<td>3.7</td>
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<tr>
<td>87-90</td>
<td>B+</td>
<td>3.3</td>
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<tr>
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<td>B</td>
<td>3.0</td>
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<td>80-83</td>
<td>B-</td>
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<tr>
<td>77-80</td>
<td>C+</td>
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<tr>
<td>&lt;60</td>
<td>F</td>
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**Reading Material**

Hand-outs will be distributed throughout the course. Published manuscripts will be chosen by the professor and presented and discussed in class by students. Below are some optional resources you might want to use.

**Optional textbooks:**

2. *Light in Water* by Curtis Mobley (electronic version freely available)
3. *IOCCG reports* (all freely available at [http://www.ioccg.org/reports_ioccg.html](http://www.ioccg.org/reports_ioccg.html))

**Safety and gear**

Details will be provided before the course starts. Safety training will be provided by the NOAA staff as part of the course orientation. NOAA will also require documents about your contact information.

**Required gear to work on the boat:**

Steel-toed, waterproof boots are required to work on the boat.

**Recommended gear:**
Waterproof and warm clothes:

- Rain gear overalls are a great way to stay dry while on deck
- Use layers so you can rapidly adapt to the weather conditions.

**Software**

Hands-on computer class activities will require the use of either SeaDAS or Matlab® and will be carried out or in Room 435 (4th floor) in the Earth and Environment Department when the room is available. Although the hands-on activities are aimed to familiarize students with using these tools, you are also strongly encouraged to get the software on your personal computers and to practice using them individually or in groups. SeaDAS is freely available from the NASA website (http://seadas.gsfc.nasa.gov), and university licenses for Matlab® are available for your personal computer by contacting CAS IT.

**Academic integrity**

- Students must adhere to the Boston University Academic Conduct Code: http://www.bu.edu/academics/policies/academic-conduct-code/

- Graduate students must adhere to the Graduate Code: http://www.bu.edu/cas/students/graduate/grs-forms-policies-procedures/academic-discipline-procedures/

- For written assignments, any information presented from an outside source (books, news papers, online sources) must be cited appropriately. Paraphrasing without citation will be considered plagiarism.

- Infractions will be handled in accordance with university policy, and can result in a zero for the assignment, or reduction in course grade.

**Student with disabilities**

Accommodations for students with disabilities will be provided in accordance with the policies of Boston University.