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
COURSE NUMBER: ES 420/620
CAS GRS

COURSE TITLE: Aquatic Optics and Remote Sensing

INSTRUCTOR(S): Fichot

TO BE FIRST OFFERED: Sem./Year: __Spring__ / __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.

An introduction to the use of optical measurements and remote sensing to study the biogeochemistry and water quality of aquatic environments. The course will cover fundamental concepts and measurements in optics/remote sensing and provide hands-on experience with real data.

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:

   ES 107 AND ES 270, OR Consent of Instructor.
   GE 302 (recommended)

2. Explain the need for these prerequisites:
   Students should have a basic understanding of earth systems, climate and data analysis. Instructor consent will be required for those students without ES 107 and ES 270. GE 302, introduction to remote sensing, is recommended, but not required.

CREDITS: (check one)
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 course will include 180 min of class meeting per week. In addition to class meeting time, students will be expected to spend at least 8-10 hours per week to complete homework assignments, prepare to lead class paper discussions, to prepare oral presentations, and to complete research projects.

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  ☐ Every other year
☐ Once a year, spring  ☐ 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 ES420/620 course will be a new elective available to graduate students and to upper-level undergraduate students; for the latter, we envision strong enrollments from students in the new Earth Observations “track” within the “Earth and Environmental Sciences” undergraduate program. Despite department strength in geospatial sciences, there are currently no courses offered on the remote sensing of aquatic environments. This course intends to fill in this gap and to provide opportunities for a more comprehensive and well-rounded education in remote sensing. In particular, this course will represent a new and attractive course option for professional M.A. students in our new program in Remote Sensing and Geospatial Sciences. This course will merge elements of optics and remote sensing with elements of marine science, biogeochemistry and climate science, and will therefore also represent a new elective for undergraduate and Ph.D students interested in marine science or the biogeoosciences. The course aims to provide students with both a theoretical and practical knowledge of optics and remote sensing and of its utility in earth and environmental research and applied sciences. In addition to gaining fundamental knowledge in aquatic optics, students will develop hands-on skills for accessing, processing, and using ocean color remote sensing data for their own research (using primarily SeaDAS and Matlab®). The course will also
aim to develop students’ abilities to critically evaluate published scientific work in this field, and to communicate scientific information and results effectively.

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

A total of 10-12 students. Most are expected to be PhD students in the Department of Earth and Environment, as well as professional M.A students in our new program in Remote Sensing and Geospatial Sciences. We anticipate ~5 upper-level undergraduates each offering (e.g., several students pursuing the new earth observations “track” in our undergraduate major in Earth & Environmental Sciences).

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
   x 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 use current departmental resources, including the Matlab® software, and the use of departmental computing facilities (Room 435 of the Department of Earth and Environment).

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.

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.)

*No additional items are requested for this course.*

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:  

\[Signature\]  

10/18/16  

Department Chair  

Date

Other Department Chair(s) (for cross-listed courses)  

Date

DEAN’S OFFICE CURRICULUM ADMINISTRATOR USE ONLY

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

Aquatic environments cover more than 70% of the Earth’s surface, host some of our most important resources, and represent a major regulator of global biogeochemical cycles and climate. Water bodies are also subject to the ever-growing pressures of human activities and climate change, but our ability to monitor, study and predict their impacts is directly challenged by the inherent heterogeneity and dynamic nature of these environments. Optical measurements and remote sensing represent unparalleled tools for making sustained measurements of some of the vitals of aquatic environments and to capture their variability on relevant spatial and temporal scales. In this course, we will review the fundamental concepts behind the use of optical measurements and remote sensing to monitor and study aquatic environments. The course will cover topics ranging from in-water optical properties, radiometry, radiative transfer, algorithm development, field optical instrumentations, satellite sensors. A significant portion of the course
will also focus on applications of aquatic optics and remote sensing for the biogeoosciences and water quality.

The course is intended for upper-level undergraduate and graduate students interested in remote sensing and/or the aquatic sciences. It aims to provide those students with both a theoretical and practical knowledge of optics and remote sensing and of its utility in earth and environmental research and applied sciences. More specifically, students can expect to gain an understanding of:

- How light and in-water constituents interact in aquatic environments
- The main quantities and properties in aquatic optics and remote sensing
- The utility of optical measurements and remote sensing in research and applied sciences
- Challenges and uncertainties faced in this field
- How to access, process, and use field optical and ocean color remote sensing data

The course is also expected to help students improve or polish their oral and writing communications skills.

**Prerequisites**

- ES 107 and ES 270, or permission of instructor
- GE 302 (recommended but not required)

**Course Elements**

The course will include a balanced mixture of lectures, student-led discussions of seminal and controversial papers in the field, hands-on computer activities and research projects using real data, student oral presentations, and scientific writing.

**Lectures**

Lectures will be given throughout the course by the professor in order to familiarize the students with the fundamentals concepts of the course. Guidance will also be provided with regards to oral and writing communication.

**Homework assignments**

All students will have to complete homework assignments each week. It will typically be a reading assignment and/or a quantitative problem to solve. Assignments are due at the beginning of class unless otherwise stated, and a late penalty of 10% per day will be applied. If extenuating circumstances arise and you need an extension, you must arrange this with the professor prior to the original lab due date. Assignments cannot be turned in for credit after the exercise has been graded and returned to the class.

**Paper/topic discussions**

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.

- **Hands-on activities in computer lab**
  These activities will aim to familiarize the students with accessing, processing, and utilizing real optical and ocean color remote sensing data. The knowledge gained through these activities will help the students complete their research projects.

- **Research project manuscript and presentation**
  **Undergraduate students (ES 420):** The professor will assign a topic for the undergraduate students to research and report on. Students will have to present their findings in a 5-8-page research paper and do a short 15-20 min oral presentation for the class.

  **Graduate students (ES 620):** The research project will require graduate students to define a research question (topic: biogeoscience or water quality) and address the question using real ocean color remote sensing data and field data freely available from NASA or the USGS. The topic of the projects will be finalized by the first class after Spring Break. Students will have to present and discuss their results in a concise scientific manuscript (AGU *Geophysical Research Letters* journal format style) and also present their results to the rest of the class in a 20-25 min presentation.

- **Exams**
  There will be a mid-term exam and a final exam.

- **Grading**
  Students are expected to attend all classes and arrive on time. If you must be absent from class discussion, please contact the professor before the missed class to make arrangements. Students are also expected to come to class well prepared and to participate in class, and the grade will reflect the level of participation and preparedness of the student.

- **Summary**

  - Attendance and participation: 10%
  - Assignments: 10%
  - Paper presentation and discussion: 10%
  - Research project
    - Manuscript: 15%
    - Oral presentation: 15%
  - Mid-term exam: 20%
  - Final exam: 20%

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<thead>
<tr>
<th>Percentage</th>
<th>Letter</th>
<th>GPA</th>
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**Course Schedule**

The first part of the course (until spring break) will focus on theoretical and field aquatic optics, whereas the second part of the course (after spring break) will focus on how these concepts are reused in remote sensing (ocean color), and on their use in research and applied sciences. The course schedule might vary slightly from the general schedule presented below depending on enrollment.

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
<th>Class activities</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Jan 19-20</td>
<td>Introduction/overview</td>
<td>###</td>
</tr>
<tr>
<td>2</td>
<td>Jan 23-27</td>
<td>Fundamentals of light and matter interactions</td>
<td>Paper/topic discussion</td>
</tr>
<tr>
<td>3</td>
<td>Jan 30 - Feb 03</td>
<td>Inherent optical properties (IOPs) of natural water constituents: Part 1</td>
<td>Paper/topic discussion</td>
</tr>
<tr>
<td>4</td>
<td>Feb 06-10</td>
<td>Inherent optical properties (IOPs) of natural water constituents: Part 2</td>
<td>Activity in Fichot Lab (when lab is ready)</td>
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<tr>
<td>5</td>
<td>Feb 13-17</td>
<td>Radiometry and apparent optical properties (AOPs)</td>
<td>Paper/topic discussion</td>
</tr>
<tr>
<td>6</td>
<td>Feb 20-24</td>
<td>Radiative transfer in water, inverse and forward modeling, algorithms</td>
<td>Hydrolight® demo</td>
</tr>
<tr>
<td>7</td>
<td>Feb 27 -Mar 03</td>
<td>Field optical instrumentation  Mid-term exam</td>
<td>Exam</td>
</tr>
</tbody>
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**Spring Break**

| 8    | Mar 13-17  | Satellite ocean color: Measurements, sensors, and data               | Hands-on activity in computer lab (SeaDAS) |
| 9    | Mar 20-24  | Atmospheric Corrections                                              | Hands-on activity in computer lab (SeaDAS) |
| 10   | Mar 27-31  | Challenges and uncertainties in ocean color remote sensing           | Paper/topic discussion                    |
| 11   | Apr 03-07  | Research and applications in biogeoosciences and for water quality: Part 1 | Hands-on activity in computer lab (SeaDAS) |
| 12   | Apr 10-14  | Research and applications in biogeoosciences and for water quality: Part 2 | Hands-on activity in computer lab (SeaDAS) |
| 13   | Apr 17-21  | Research and applications in biogeoosciences and for water quality: Part 3 Student presentations | Oral presentations                      |
| 14   | Apr 24 -28  | Student presentations                                                | Oral presentations                        |
| 15   | May 3      | Review                                                               | ###                                      |
# Exam Schedule

<table>
<thead>
<tr>
<th>Exam</th>
<th>Date</th>
<th>Subject</th>
</tr>
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<tbody>
<tr>
<td><strong>Mid-term exam</strong></td>
<td>During last week before Spring Break (Mar 1-3)</td>
<td>All material from weeks 1 to 7</td>
</tr>
<tr>
<td><strong>Final Exam</strong></td>
<td>During final exam period (May 8-12)</td>
<td>All material from weeks 8 to 15</td>
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# Reading material

Reading material for the class will consist of handouts and published manuscripts, but below are some optional resources you might want to put your hands on.

**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))

# Software

Hands-on computer class activities will require the use of either SeaDAS or Matlab® and will be carried out in Room 435 (4th floor) in the Earth and Environment Department. 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](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/](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/](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.
Accommodations for students with disabilities will be provided in accordance with the policies of Boston University.
Cognate Comment Request

TO: Name: Pamela Templer, Director of Biogeoscience Program

Department: Biology

FROM: Name: David Marchant, Chair

Department: Earth & Environment

Telephone: 3-3236  E-mail marchant@bu.edu

Course Number: CAS/GRS ES 420/620

Course or Program Title: Aquatic Optics and Remote Sensing

The Department of Earth & Environment would like to request cognate comments on this course. It may be of interest to your students in the biogeoscience program. A complete proposal and course syllabus is attached for your review. If you need further information, please do not hesitate to contact me.

Kindly return the signed original to me by 10/14/2016 so that we may include your comments when submitting our proposal for review and approval. Please do not send any cognate letters directly to the dean’s office. Thank you.

COMMENTS: I enthusiastically support this new course. I believe it will be a great course for students in the Biogeoscience Program to consider taking.

Please explain fully any objections.

Signature: Pamela Templer  Date: October 14, 2016

Title: Associate Professor of Biology and Director of Biogeoscience Program